EAST WATERWAY OPERABLE UNIT SUPPLEMENTAL REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

QUALITY ASSURANCE PROJECT PLAN: SUBSURFACE SEDIMENT SAMPLING FOR CHEMICAL ANALYSES IN THE EAST WATERWAY

For submittal to:

The US Environmental Protection Agency
Region 10
Seattle, WA

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Prepared by: Windward environmental LLC

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TITLE AND APPROVAL PAGE
EW SUBSURFACE SEDIMENT SAMPLING AND ANALYSES
QUALITY ASSURANCE PROJECT PLAN

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Acronyms

ACRONYM	Definition
%RSD	percent relative standard deviation
ANSETS	Analytical Services Tracking System
ARI	Analytical Resources, Inc.
BHC	benzene hexachloride
CFR	Code of Federal Regulations
COC	chain of custody
CSL	cleanup screening level
CSM	conceptual site model
CSO	combined sewer overflow
CVAA	cold vapor atomic absorption
DGPS	differential global positioning system
DMMP	Dredged Material Management Program
DQI	data quality indicator
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
EW	East Waterway
EWG	East Waterway Group
FC	field coordinator
FS	feasibility study
GC/ECD	gas chromatography/electron capture detection
GC/FPD	gas chromatography/flame photometric detection
GC/MS	gas chromatography/mass spectrometry
GC/MS/MS	gas chromatography/mass spectrometry/mass spectrometry
GIS	geographic information system
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectrometry
HSP	health and safety plan
ICP-AES	inductively coupled plasma-atomic emission spectrometry
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
LCS	laboratory control sample

ACRONYM	Definition
MDL	method detection limit
ML	maximum level
MLLW	mean lower low water
MS	matrix spike
MNR	monitored natural recovery
MSD	matrix spike duplicate
NAD83	North American Datum of 1983
OPR	ongoing precision and recovery
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PM	project manager
PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SIM	selected ion monitoring
SL	screening level
SMS	Washington State Sediment Management Standards
SOP	standard operating procedure
SQS	sediment quality standards
SRI	supplemental remedial investigation
SRM	standard reference material
SVOC	semivolatile organic compound
T-18	Terminal 18
T-30	Terminal 30
TBT	tributyltin
TM	task manager
TOC	total organic carbon
USCG	US Coast Guard
VOC	volatile organic compound
Windward	Windward Environmental LLC

1 Introduction

This quality assurance project plan (QAPP) describes the quality assurance (QA) objectives, methods, and procedures for collecting and chemically analyzing samples from subsurface sediment cores in the East Waterway (EW) in Seattle, WA (Map 1-1). Data from these studies will be used to determine the nature and extent of chemical contamination at depth for the EW supplemental remedial investigation (SRI) and to support the feasibility study (FS). This QAPP presents the study design, including details on project organization, field data collection, laboratory analysis, and data management. This QAPP was prepared in accordance with US Environmental Protection Agency (EPA) guidance for preparing QAPPs (2002).

This plan is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Project Management
- Section 3 – Data Generation and Acquisition
- Section 4 – Assessment and Oversight
- Section 5 – Data Validation and Usability
- Section 6 – References

A health and safety plan (HSP) designed to protect onsite personnel from physical, chemical, and other hazards posed during field sampling activities is included as Appendix A. Field collection forms are included as Appendix B. Method detection limits (MDLs) and reporting limits (RLs) are presented in Appendix C. Appendix D contains maps of historical surface sediment sampling locations in the EW and a table that lists all historical subsurface sediment locations with chemical exceedances of sediment quality standards (SQS) or cleanup screening levels (CSLs) of the Washington State Sediment Management Standards (SMS) and screening levels (SLs) or maximum levels (MLs) of the Dredged Material Management Program (DMMP). Appendix E presents the sampling methods for the geotechnical and chemical evaluation in the mound area off the northwest corner of Terminal 25 in the EW. Appendix F provides a review of previously collected sediment cores to summarize the depth to native sediment in the EW. Appendix G describes the data management rules for the subsurface chemistry data. Appendix H provides the laboratory quality control limits.

2 Project Management

This section describes the overall management structure of the project, identifies key personnel, and describes their responsibilities, including field coordination, QA and quality control (QC), laboratory management, and data management. The East

Waterway Group (EWG) and EPA will be involved in all aspects of this project, including the discussion, review, and approval of the QAPP and the interpretation of the results of the investigation.

2.1 PROJECT ORGANIZATION AND TEAM MEMBER RESPONSIBILITIES

This sampling effort will be lead by Windward Environmental LLC (Windward) for the EWG. The overall project organization and the individuals responsible for the various tasks required for the subsurface sediment sample collection and analysis are shown in Figure 2-1. Responsibilities of project team members, as well as laboratory project managers (PMs), are described in the following subsections.

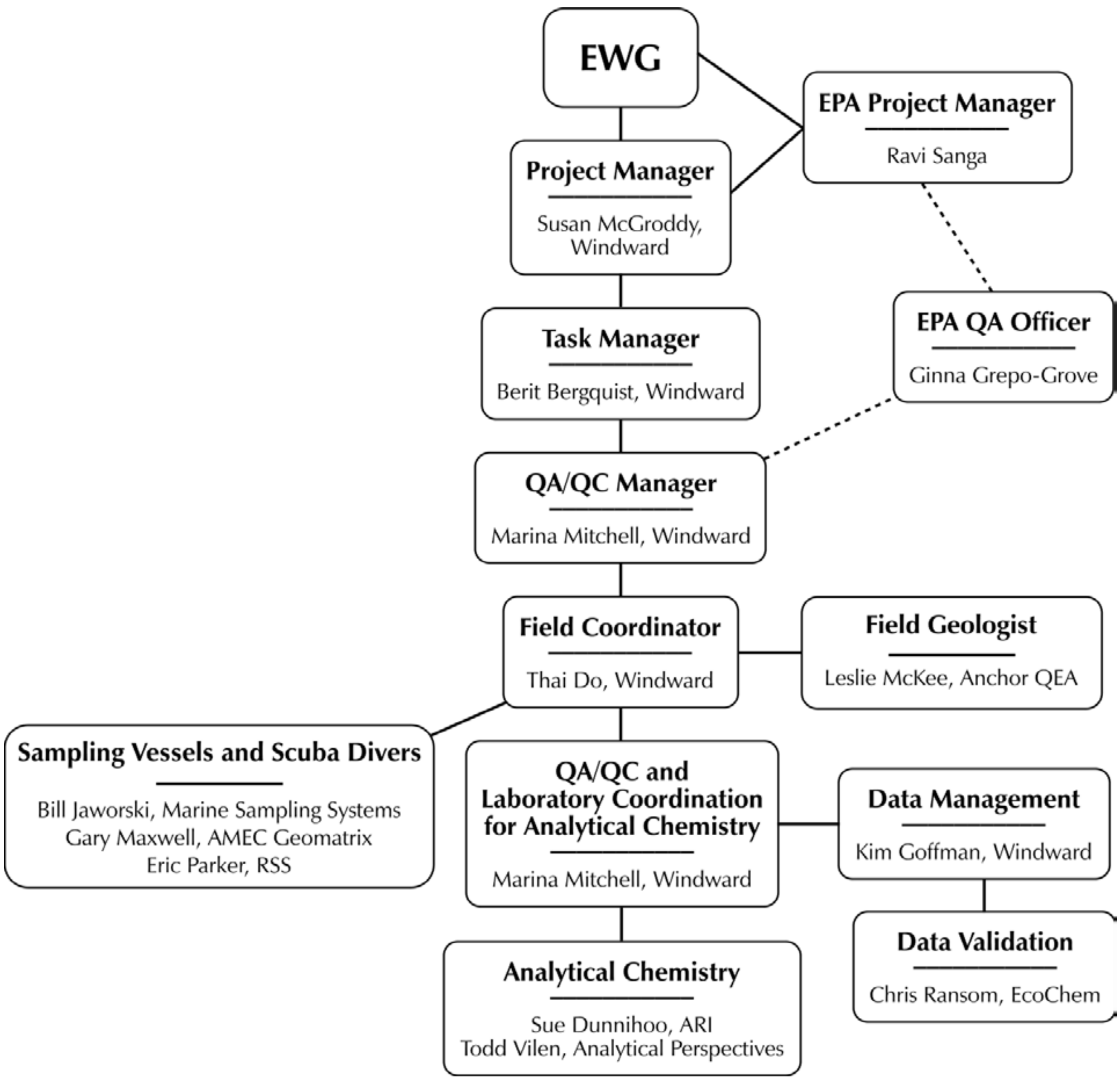


Figure 2-1. Project organization

2.1.1 Project management

EPA will be represented by its PM, Ravi Sanga. Mr. Sanga can be reached as follows:

Mr. Ravi Sanga
US Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900
ECL-111
Seattle, WA 98101-3140
Telephone: 206.553.4092
Facsimile: 206.553.0124
E-mail: Sanga.Ravi@epamail.epa.gov

Susan McGroddy will serve as the Windward PM and will be responsible for overall project coordination, providing oversight on planning and coordination, work plans, all project deliverables, and for the performance of the administrative tasks needed to ensure timely and successful completion of the project. She will also be responsible for coordinating with EWG and EPA on schedule, deliverables, and other administrative details. Dr. McGroddy can be reached as follows:

Dr. Susan McGroddy
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5421
Facsimile: 206.217.0089
E-mail: susanm@windwardenv.com

Berit Bergquist will serve as the Windward task manager (TM). The TM is responsible for project planning and coordination, production of work plans, production of project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. The TM is responsible for communicating with the Windward PM on the progress of project tasks and any deviations from the QAPP. Significant deviations from the QAPP will be further reported to EWG and EPA. Ms. Bergquist can be reached as follows:

Ms. Berit Bergquist
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5403
Facsimile: 206.217.0089
E-mail: beritb@windwardenv.com

2.1.2 Field coordination

Thai Do will serve as the Windward field coordinator (FC). The FC is responsible for managing the field sampling activities and general field and QA/QC oversight. He will ensure that appropriate protocols for sample collection, preservation, and holding times are observed and will oversee delivery of environmental samples to the designated laboratories for chemical analysis. Mr. Do can be reached as follows:

> Mr. Thai Do
> Windward Environmental LLC
> 200 W Mercer Street, Suite 401
> Seattle, WA 98119
> Telephone: 206.812.5407
> Cellular phone: 206.919.1597
> E-mail: thaid@windwardenv.com

Leslie McKee will serve as the field geologist and will coordinate the processing and logging of sediment cores. Ms. McKee can be reached as follows:

> Ms. Leslie McKee
> Anchor QEA
> 1605 Cornwall Ave.
> Bellingham, WA 98225
> Telephone: 360.733.4311
> Cellular phone: 847.454.6652
> E-mail: lmckee@anchorqea.com

Gary Maxwell (or other qualified personnel) will serve as the boat captain for the MudMole™ sampling, and Bill Jaworski will serve as the boat captain for the vibracorer sampling. The boat captain is responsible for operating the boat and for decisions related to boating operations. The boat captain will work in close coordination with the FC to ensure that samples are collected consistent with the methods and procedures presented in this QAPP. Mr. Maxwell and Mr. Jaworski can be reached as follows:

> Mr. Gary Maxwell
> AMEC Geomatrix
> 3500 188th St. SW, Suite 600
> Lynnwood, WA 98037
> Telephone: 425.921.4000
> E-mail: gary.maxwell@amec.com

> Mr. Bill Jaworski
> Marine Sampling Systems
> P.O. Box 290
> Burley, WA 98322
> Telephone: 253.857.3336

Scuba divers from Research Support Services, Inc. (RSS) will assist with the collection of all cores collected using the MudMole™ where the water depth is greater than 5 ft. Eric Parker will be responsible for all diving operations and can be reached as follows:

Mr. Eric Parker
(b) (6)
Bainbridge Island, WA 98110
Telephone: 206.550.5202
E-mail: eparker@rssincorporated.com

2.1.3 Quality assurance/quality control

Marina Mitchell of Windward will serve as QA/QC manager and coordinator for chemical analyses for the project. As the QA/QC manager, she will provide oversight for both the field sampling and laboratory programs, and will supervise data validation and project QA coordination, including coordination with the EPA QA officer, Ginna Grepo-Grove.

Ms. Mitchell can be reached as follows:

Ms. Marina Mitchell
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5424
Facsimile: 206.217.0089
E-mail: marinam@windwardenv.com

Ms. Grepo-Grove can be reached as follows:

Ms. Ginna Grepo-Grove
US Environmental Protection Agency, Region 10
1200 6th Avenue
Seattle, WA 98101
Telephone: 206.553.1632
E-mail: grepo-grove.gina@epa.gov

The Windward QA/QC manager will ensure that samples are collected and documented appropriately and coordinate with the analytical laboratories to ensure that QAPP requirements are followed.

EcoChem Inc. will provide independent third-party review and validation of analytical chemistry data. Chris Ransom will act as the data validation PM and can be reached as follows:

Ms. Chris Ransom
EcoChem Inc.
Dexter Horton Building
710 Second Avenue, Suite 600
Seattle WA 98104
Telephone: 206.233.9332
E-mail: cransom@ecochem.net

2.1.4 Laboratory project management

Analytical Resources, Inc. (ARI) and Analytical Perspectives will perform chemical analyses. Sue Dunnihoo will serve as the laboratory PM for ARI and Todd Vilen will serve as the laboratory PM for Analytical Perspectives. The laboratory PMs can be reached as follows:

Ms. Susan Dunnihoo
Analytical Resources, Inc.
4611 S 134th Place, Suite 100
Tukwila, WA 98168
Telephone: 206.695.6207
E-mail: sue@arilabs.com

Mr. Todd Vilen
Analytical Perspectives
2714 Exchange Drive
Wilmington, NC 28405
Telephone: 910.794.1613
Facsimile: 910.794.3919
E-mail: tvilen@utratrace.com

The laboratories will accomplish the following:

- Adhere to the methods outlined in this QAPP, including those methods referenced for each procedure
- Adhere to documentation, custody, and sample logbook procedures
- Implement QA/QC procedures defined in this QAPP
- Meet all reporting requirements
- Deliver electronic data files as specified in this QAPP
- Meet turnaround times for deliverables as described in this QAPP
- Allow EPA and the QA/QC third-party auditors to perform laboratory and data audits

2.1.5 Data management

Ms. Kim Goffman will oversee data management to ensure that analytical data are incorporated into the EW database with appropriate qualifiers following acceptance of the data validation. QA/QC of the database entries will ensure accuracy for use in the SRI. Ms. Goffman can be reached as follows:

Ms. Kim Goffman
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119

Telephone: 206.812.5414
Facsimile: 206.217.0089
E-mail: kimg@windwardenv.com

2.2 Problem Definition/Background

The EW conceptual site model (CSM) and data gaps report (Windward 2004) identified the need for additional subsurface sediment samples for chemical analysis. This section presents the objectives and background information to address these data needs. An overview of the study and its schedule is presented in Section 2.3, and a detailed sampling design is presented in Section 3.1.

Collection of additional subsurface sediment chemistry data is needed in specific areas of the EW to support the EW SRI/FS (Anchor et al. 2008). In particular, additional subsurface sediment samples are needed to fulfill the following objectives:

- Supplement existing data to allow for characterization of the nature and extent of subsurface chemical concentrations as part of the SRI
- Provide data for delineation of the depth of potential cleanup areas and to support consideration of monitored natural recovery (MNR) as part of the FS

Since 1990, there have been 18 sampling events in the EW that have included the collection of subsurface sediment cores (Table 2-1). Most of these samples have been collected for the purpose of dredge material characterization. Many of the samples were collected in areas that were subsequently dredged and thus no longer represent existing conditions. Thus, the historical data available for evaluating the nature and extent of subsurface chemical concentrations in the SRI are from cores collected outside dredged areas, as shown on Map 2-1. Additional subsurface sediment data are needed to provide spatial coverage of the EW, as evaluated in Section 3.1.

Table 2-1. Subsurface sediment characterization investigations conducted in the EW since 1990

Event	Dates	Method	Samples	Analytes[a]	Status	Reference
EW – Slip 27	January 2007	vibracorer	12	SMS, pesticides, TBT	none dredged	Windward (2007)
T-30 Sediment Characterization	July 2006	vibracorer	6	DMMP	6 sample locations dredged	Anchor (2006)
Pier 36 Suitability Confirmation Sampling	November 2004	vibracorer	11	DMMP	11 sample locations dredged	GeoEngineers (2004)
T-46 Sediment Characterization	March-April 2004	vibracorer and diver-assisted spoon	2	SMS, DMMP	2 sample locations dredged	Anchor (2004)
EW/Harbor Island Nature and Extent Recency	February 2003	vibracorer	4	SMS, DMMP	4 sample locations dredged	Windward (2003)
Pier 36 Dredging Additional Sampling	November 2002	vibracorer	3	DMMP	3 sample locations dredged	GeoEngineers (2003)

Event	Sampling Dates	Collection method	Number of Samples	Analytes[a]	Dredging Status	Reference
EW T-18 Stage 1A, Rounds 1and 2	April 2002 (Round 1) September 2002 (Round 2)	vibracorer	5	DMMP	5 sample locations dredged	Anchor(2002)
USCG Pier 36	March 2001	hollow-stem auger	12	SMS, DMMP	12 sample locations dredged	GeoEngineers (2001)
EW/Harbor Island Nature and Extent – Phase 3b	December 2001	pneumatic corer	33	SMS, DMMP	1 sample location dredged	Windward (2002)
EW Stage 1 Channel Deepening	July-August 1998	vibracorer	99	SMS, DMMP	44 sample locations dredged	SAIC (1999a)
Pier 36 Characterization	August 1998	vibracorer	9	SMS, DMMP	9 sample locations dredged	SAIC (1999b)
Pier 36 - preliminary	April 1997	vibracorer	4	SMS	2 sample locations dredged	Berger/ABAM (1997)
T-18 Dredging - Phase 2	May-June 1996	vibracorer	45	SMS, DMMP	45 sample locations dredged	EVS (1998)
T-18 Dredging - Phase 1	March 1996	vibracorer	86	SMS, DMMP	77 sample locations dredged	EVS (1998)
Harbor Island SRI	March 1995	impact-driven coring system	9	SMS	8 locations dredged	EVS (1996)
Pier 36	March 1992	hollow-stem auger	3	SMS	None dredged	Shannon and Wilson (1992)
Harbor Island RI	September-October 1991	vibracorer	6	SMS	5 locations dredged	Weston (1993)
Pier 27	June 1990	vibracorer	24	SMS	None dredged	Smolski et al.(1991)

[a] SMS analytes included PCBs (as Aroclors), SVOCs, VOCs, metals (arsenic, cadmium, chromium, copper, lead, mercury, silver, zinc), TOC, and grain size. DMMP analytes included PCBs (as Aroclors), pesticides, SVOCs, TBT, metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc), TOC, and grain size.

DMMP – Dredged Material Management Program
EW – East Waterway
PCB – polychlorinated biphenyl
RI – remedial investigation
SMS – Washington State Sediment Management Standards
SVOC – semivolatile organic compound
T-18 – Terminal 18
T-30 – Terminal 30
T-46 – Terminal 46
TBT – tributyltin
TOC – total organic carbon
USACE – US Army Corps of Engineers
VOC – volatile organic compound

2.3 Project/Task Description and Schedule

The sampling of subsurface sediment will be initiated following EPA's approval of this QAPP. This section provides an overview of the sampling and analysis activities and schedule for the subsurface sediment investigation. A detailed sampling design is presented in Section 3.1.

Sampling is scheduled to occur in early 2010. Two separate field crews will work simultaneously; one crew will collect sediment cores and a second crew will log and process the sediment cores immediately following collection. Sediment cores will be collected at 65 locations. Sediment samples taken from the cores will be submitted to ARI and Analytical Perspectives for chemical analyses (see Section 3.4.2.1). A total of 2 sediment samples from each core (130 samples) will be analyzed for metals, polychlorinated biphenyls (PCBs) (as Aroclors), semivolatile organic compounds (SVOCs), total organic carbon (TOC), total solids, and grain size. In addition, tributyltin (TBT) will be analyzed in 2 samples from 21 cores (42 samples), and pesticides will be analyzed in 2 samples from 9 cores (18 samples). Remaining samples collected from the cores will be archived at ARI. Chemical analyses of the samples, as described in Section 3.4.2, are expected to be completed three weeks after samples have been collected. When preliminary, unvalidated data are available from this sampling event and from the 2009 SRI surface sediment sampling event, they will be evaluated by EWG and EPA to select archived samples for additional analyses, as described in Section 3.1.3. Chemical data from the additional round of analyses will be available 3 weeks after the archived samples have been submitted for analysis. Validated data are expected to be received approximately 5 weeks after the final chemical analyses are complete. A draft report presenting the chemical data will be submitted to EPA 8 weeks after validated data are received. Thus, the total time from the completion of sampling to the submittal of the data report to EPA is 19 weeks (i.e., 6 weeks for chemical analyses of both initial and archived samples, 5 weeks for data validation, and 8 weeks for report preparation), plus the time needed to select samples for the additional analyses.

2.4 Data Quality Objectives and Criteria

The overall data quality objective (DQO) for this project is to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality. Parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. These parameters are discussed, and specific data quality indicators (DQIs) for sediment chemistry analysis are presented in Sections 3.4.1.2 and 3.4.2.2, respectively.

2.5 Special Training/Certification

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations providing health and safety standards and guidelines for workers engaged in hazardous waste operations. The federal regulation 29 CFR 1910.120 requires training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course and 8-hour refresher courses, as necessary, to meet the Occupational Safety and Health Administration regulations.

2.6 Documentation and Records

The following sections describe documentation and records needed for field observations and laboratory analyses.

2.6.1 Field observations

All field activities will be recorded in a field logbook maintained by the FC. The field logbook will provide a description of all sampling activities, conferences associated with field sampling activities, sampling personnel, and weather conditions, plus a record of all modifications to the procedures and plans identified in this QAPP and the HSP (Appendix A). The field logbook will consist of bound, numbered pages. All entries will be made in indelible ink. The field logbook is intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the sampling period.

The following forms, included as Appendix B, will also be used to record pertinent information during core collection and processing:

- Sediment core collection log
- MudMole™ bore log
- Sediment core processing log
- Protocol modification form

During core collection, field personnel will record field conditions and drive notes on the sediment core collection log and MudMole™ bore log. The recorded data will include the following:

- Depth from the water surface to mudline using a leadline[1]
- Location of each station as determined by DGPS
- Date and time of collection of each sediment core sample
- Names of field personnel collecting and handling the cores
- Observations made during core collection, including weather conditions, complications, ship traffic, and other details associated with the sampling effort
- The sample station identification
- Length and depth intervals of each core section and estimated recovery for each sediment sample as measured from MLLW
- Qualitative notation of apparent resistance of sediment column to coring (how the core drove)
- Any deviation from the approved QAPP

During core processing, a sediment description of each core will be recorded on the sediment core processing log. The following parameters will be noted:

[1] This depth will be used to calculate the mudline elevation relative to MLLW after sampling using tidal elevation data (see Section 3.2.2).

- Sample recovery
- Physical soil description in accordance with ASTM procedures (ASTM D 2488 and ASTM D 2487 - Unified Soil Classification System) including soil type, density/consistency of soil, and color
- Odor (e.g., hydrogen sulfide, petroleum)
- Visual stratification, structure, and texture
- Vegetation and debris (e.g. woodchips or fibers, paint chips, concrete, sand blast grit, metal debris
- Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
- Presence of oil sheen

2.6.2 Laboratory records

The laboratory record requirements for the sediment chemistry data are described below. All of the contract laboratories to be used for this investigation are accredited by the Washington State Department of Ecology (Ecology).

The chemistry laboratories will be responsible for internal checks on sample handling and analytical data reporting and will correct any errors identified during the QA review. Data packages from the laboratories will be submitted electronically and will include the following:

- **Project narrative –** This summary, in the form of a cover letter, will present any problems encountered during any aspect of analysis. The summary will include, but not be limited to, a discussion of QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered by the laboratory, and their resolutions, will be documented in the project narrative.
- **Records –** Legible copies of the chain-of-custody (COC) forms will be provided as part of the data package. This documentation will include the time of receipt and the condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.
- **Sample results –** The data package will summarize the results for each sample analyzed. The summary will include the following information, as applicable:
  - Field sample identification (ID) code and the corresponding laboratory ID code
  - Sample matrix
  - Date of sample extraction/digestion
  - Date and time of analysis
  - Weight and/or volume used for analysis

- Final dilution volumes or concentration factor for the sample
- Percent moisture in the samples
- Identification of the instruments used for analysis
- MDLs and RLs
- All data qualifiers and their definitions

- **QA/QC summaries –** These summaries will contain the results of all QA/QC procedures. Each QA/QC sample analysis will be documented with the same information as that required for the sample results (see above). The laboratory will make no recovery or blank corrections. The required summaries are listed below.
  - The calibration data summary will contain the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent relative standard deviation (%RSD), relative percent differences (RPDs), and retention time for each analyte will be listed, as appropriate. Results for standards analyzed at the RL to determine instrument sensitivity will be reported.
  - The internal standard area summary will report the internal standard areas, as appropriate.
  - The method blank analysis summary will report the method blank analysis associated with each sample and the concentrations of all compounds of interest identified in these blanks.
  - The surrogate spike recovery summary will report all surrogate spike recovery data for organic analyses. The names and concentrations of all compounds added, percent recoveries, and QC limits will be listed.
  - The matrix spike (MS) recovery summary will report the MS or MS duplicate (MSD) recovery data for analyses, as appropriate. The names and concentrations of all compounds added, percent recoveries, and QC limits will be included in the data package. The RPD for all MS/MSD analyses will be reported.
  - The laboratory replicate summary will report the RPD for all laboratory replicate analyses. The QC limits for each compound or analyte will be listed.
  - The standard reference material (SRM) analysis summary will report the results and recoveries of the SRM analyses and list the accuracy, as defined in Section 3.4.2, for each analyte, when available.
  - The laboratory control sample (LCS) analysis summary will report the results of the analyses of the LCS. The QC limits for each compound or analyte will be included in the data package.

    - The relative retention time summary will report the relative retention times for the primary and confirmational columns of each analyte detected in the samples, as appropriate.
- **Original data –** Legible copies of the original data generated by the laboratory will be provided, including the following:
    - Sample preparation, extraction/digestion, and cleanup logs
    - Instrument analysis logs for all instruments used on days of calibration and analysis
    - Chromatograms for all samples, blanks, calibration standards, MS/MSD, laboratory replicate samples, LCS, and SRM samples for all gas chromatography analyses
    - Reconstructed ion chromatograms of target chemicals detected in the field samples and method blanks for all gas chromatography/mass spectrometry (GC/MS) analyses
    - Enhanced and unenhanced spectra of target chemicals detected in field samples and method blanks, with associated best-match spectra and background-subtracted spectra, for all GC/MS analyses.
    - Quantitation reports for each instrument used, including reports for all samples, blanks, calibrations, MS/MSD, laboratory replicates, LCS, and SRMs

The contract laboratories for this project will submit data electronically in EarthSoft EQuIS® standard four-file. Guidelines for electronic data deliverables for chemical data is provided on the EarthSoft website, http://www.earthsoft.com/en/index.html, and additional information will be communicated to the laboratories by the project QA/QC coordinator or data manager. All electronic data submittals must be tab-delimited text files with all results, MDLs, and RLs reported to the appropriate number of significant figures. If laboratory replicate analyses are conducted on a single submitted field sample, the laboratory sample identifier must distinguish among the replicate analyses.

2.6.3 Data reduction

Data reduction is the process by which original data are converted or reduced to a specified format or unit to facilitate the analysis of the data. For example, a final analytical concentration may need to be calculated from a diluted sample result. Data reduction requires that all aspects of sample preparation that could affect the test result, such as sample volume analyzed or dilutions required, be taken into account in the final result. It is the laboratory analyst's responsibility to reduce the data, which are subjected to further review by the laboratory PM, the Windward PM, the project QA/QC coordinator, and independent reviewers. The data will be generated in a form amenable to review and evaluation. Data reduction may be performed manually or electronically. If performed electronically, all software used must be demonstrated to be true and free from unacceptable error.

During chemical analysis, samples are occasionally diluted after the initial analysis if the estimated concentration curve for one or more of the target analytes is above the calibration curve. In these instances, concentrations from the initial analysis will be identified as the "best result" for all target analytes other than the chemical(s) that was originally above the calibration range. The "best result" for this qualified analyte(s) will be taken from the diluted sample.

2.6.4 Data report

A data report will be prepared documenting all activities associated with the collection, handling, and analysis of samples. At a minimum, the following will be included in the data reports:

- Summary of all field activities, including descriptions of any deviations from the approved QAPP
- Copies of field forms, including core collection logs, MudMole™ bore logs, and sediment core processing logs
- Summary spreadsheet containing information from field forms
- Sediment sampling locations reported in latitude and longitude to the nearest one-tenth of a second and in northing and easting to the nearest foot
- Plan view of the project showing the actual sampling locations
- Summary of the QA/QC review of the analytical data
- Data validation reports (appendices)
- Results from the analysis of field samples (including field QC samples), both as summary tables in the main body of the report and appendices with data forms submitted by the laboratories and as crosstab tables produced from Windward's database

Analytical data will be validated within 4 weeks of the receipt of data packages from the laboratories. A draft data report will be submitted to EPA (date tbd). Once the data report has been approved by EPA, a database export will be created from Windward's database. The data will be exported in a format compatible with Ecology's Environmental Information Management System, which consists of separate tables for events, locations, samples, and results. Data will also be provided to EPA in Microsoft Access®. Any relevant geographic information system (GIS) files will also be transmitted to EPA.

3 Data Generation and Acquisition

This section describes the collection and handling of sediment samples for chemical analyses. Elements include sampling design; sampling methods; sample handling and custody requirements; analytical methods; QA/QC, instrument/equipment testing and frequency, inspection and maintenance; instrument calibration; supply inspection/acceptance; and data management.

3.1 SAMPLING DESIGN

This section describes the sampling design developed to meet the data needs presented in Section 2.2 for the placement of subsurface sediment samples and the chemical analyses of these samples.

3.1.1 Sampling locations

The primary objectives of the subsurface sediment sampling are to characterize the nature and extent of subsurface chemical contamination in the EW as part of the SRI, and to provide data to delineate the depth of potential cleanup areas and support consideration of MNR in the FS. The following information was used in considering the selection of core locations:

- **Existing surface sediment data –** Existing surface sediment chemistry data collected since 1995 were evaluated and core locations were placed in selected areas with elevated chemical concentrations based on comparisons to the SQS/CSL and SL/ML (Maps 2-2a and 2-2b). Within the Phase 1 dredge area, surface sediment data collected after dredging but prior to clean sand placement were evaluated to determine the need for additional subsurface cores in this area (Map 2-3). Surface sediment chemistry data were collected for the SRI/FS in March 2009 and a second round of sampling is planned for May 2009; preliminary chemistry data will be reviewed as soon as they are available. Additional locations may be selected based on these new data.
- **Existing subsurface sediment data –** Subsurface sediment chemistry data collected in the EW since 1990 were reviewed and some locations were selected for resampling if existing data were not sufficient to evaluate the vertical extent of contamination (e.g., if chemical concentrations were above the CSL of the SMS within the deepest core interval or if the resolution of the core intervals was larger than the preferred depth of 2 ft) (Maps 2-2a and 2-2b). Existing subsurface sediment sampling locations and data for samples with chemical concentrations exceeding the SQS/CSL and SL/ML are presented in Appendix D.
- **Proximity to outfalls –** Outfalls were evaluated in selecting subsurface sampling locations because they are considered potential sources of subsurface contamination.

- **Geochronology cores –** Locations where geochronology cores will be collected separately as part of the sediment transport investigation (Anchor 2009) were considered for collection of subsurface sediment cores. Subsurface sediment cores at these locations will be analyzed at a finer depth resolution (i.e., 0.5-ft intervals compared to 2-ft intervals at other locations; see Section 3.1.2) Chemical profiles at these locations will be used in coordination with data generated from the geochronology cores to evaluate MNR as a remedial option in the FS. Geochronology core locations in the main channel of the EW were not considered for subsurface sampling because of the likelihood of disturbance of the depth profile in the upper horizon from propwash.
- **Spatial coverage –** Following the placement of cores based on the considerations above, the spatial coverage of sampling locations was reviewed to ensure that sufficient data will be available to evaluate the nature and extent of subsurface chemical concentrations throughout the EW in the SRI/FS.

Maps 2-2a, 2-2b, and 2-3 summarize the information used in the selection process for subsurface core locations, including historical surface and subsurface sampling locations, historical surface and subsurface sediment SQS/CSL exceedances, outfalls, dredged areas, and geochronology core locations. These figures also present the 63 subsurface sampling locations that were selected for sampling as a result of this selection process. Table 3-1 presents the rationale for the selection of each subsurface core location.

Table 3-1. Subsurface sediment chemistry sampling locations in the EW

Subsurface Location ID	Historical Surface or Subsurface Sample Location ID	Considerations for Placing Sampling Locations							Estimated Depth to Lower Alluvium (ft below mudline)[b]
		Sediment Quality		Outfall	Geo-chronology Core	Nature and Extent	Potential MNR Area[a]	Rationale	
		Detected Surface Chemical Exceedances	Detected Subsurface Chemical Exceedances						
1	not previously sampled	no exceedances at nearby location	no data		x	x	x	geochronology core; spatial coverage	na
2	not previously sampled	near CSL	no data	x	x	x	x	near phenol CSL exceedance in surface sediment; near storm drain 39; geochronology core; spatial coverage	na
3	not previously sampled	near CSL	no data	x		x	x	near PCB CSL in surface sediment; near storm drain 4	na
4	not previously sampled	no data	no data	x		x	x	spatial coverage; near storm drain 36	na
5	not previously sampled	no exceedances at nearby location	no data		x	x	x	spatial coverage	na
6	not previously sampled	near SQS	near CSL		x	x	x	near PCB SQS exceedance in surface sediment; near PCB, BEHP, and mercury CSL exceedances in subsurface sediment	0 –10
7	not previously sampled	no data	no data		x	x	x	geochronology core; spatial coverage	13 – 23
8	not previously sampled	near CSL	no data			x	x	near mercury CSL exceedance in surface sediment:	0 – 13
9	not previously sampled	no data	no data	x		x		near Hinds CSO; spatial coverage	0 – 3
10	not previously sampled	no data	no data	x		x		near storm drains 6 and 7; spatial coverage	na

Subsurface Location ID	Historical Surface or Subsurface Sample Location ID	Considerations for Placing Sampling Locations: Sediment Quality: Detected Surface Chemical Exceedances	Detected Subsurface Chemical Exceedances	Outfall	Geo-chronology Core	Nature and Extent	Potential MNR Area[a]	Rationale	Estimated Depth to Lower Alluvium (ft below mudline)[b]
11	2145 (surface) 2254 (subsurface)	CSL	CSL			x	x	BEHP CSL exceedance in surface sediment; PCB, mercury, BEHP, and silver CSL exceedances in subsurface sediment	0 – 11
12	not previously sampled	no data	near SQS			x		near PCB SQS exceedance in subsurface sediment; spatial coverage	2 – 15
13	1643 (subsurface)	no data	none			x		spatial coverage	2.8 – 11
14	not previously sampled	no data	no data			x		spatial coverage	2.8 – 6
15	1614 (subsurface)	no data	CSL			x		PCB CSL exceedance and mercury and BEHP SQS exceedance in subsurface sediment	3.4 – 10
16	1630 (subsurface)	no data	CSL			x		provide additional information below historical PCB CSL exceedance in 0-to-4-ft sediment core	3 – 11
17	1676 (subsurface)	no data	CSL			x		PCB and mercury CSL exceedances, bioassay CSL exceedance; spatial coverage	5 – 11
18	not previously sampled	near SQS	near SQS			x		near PCB SQS exceedance in surface sediment; near PCB and mercury SQS exceedances in subsurface sediment; spatial coverage	8 – 9
19	not previously sampled	near CSL	near CSL	x		x		additional coverage near Hanford CSO and storm drain 32; near PCB CSL exceedances in surface and subsurface sediment	0 – 5

Subsurface Location ID	Historical Surface or Subsurface Sample Location ID	Considerations for Placing Sampling Locations							Estimated Depth to Lower Alluvium (ft below mudline)[b]
		Sediment Quality		Outfall	Geo-chronology Core	Nature and Extent	Potential MNR Area[a]	Rationale	
		Detected Surface Chemical Exceedances	Detected Subsurface Chemical Exceedances						
20	not previously sampled	near CSL[c]	no data			x		near 1,4-dichlorobenzene and mercury CSL exceedance in surface sediment; spatial coverage	2
21	not previously sampled	near SQS	no data	x		x		near PCB, mercury, BEHP, and 1,4-dichlorobenzene SQS exceedances in surface sediment; near Hanford CSO and storm drain 31	0 – 5
22	not previously sampled	near CSL[c]	no data			x		near PCB CSL exceedance in surface sediment; spatial coverage	na
23	not previously sampled	near CSL	near CSL			x		near PCB, acenapthene and N-nitrosodiphenylamine CSL exceedances in surface sediment; near PCB, cadmium copper, mercury, silver, zinc, BEHP, and multiple individual PAH CSL exceedances in subsurface sediment	na
24	not previously sampled	near CSL	near CSL	x		x		additional coverage near Hanford CSO and storm drain 31; near mercury CSL exceedance in surface and subsurface sediment and 1,4-dichlorobenzene CSL exceedance in subsurface sediment	0 – 6

Subsurface Location ID	Historical Surface or Subsurface Sample Location ID	Considerations for Placing Sampling Locations: Sediment Quality: Detected Surface Chemical Exceedances	Sediment Quality: Detected Subsurface Chemical Exceedances	Outfall	Geo-chronology Core	Nature and Extent	Potential MNR Area[a]	Rationale	Estimated Depth to Lower Alluvium (ft below mudline)[b]
25	not previously sampled	near CSL[c]	no data			x		near PCB, mercury, and 1,2,4-trichlorobenzene CSL exceedances in surface sediment; spatial coverage	8 – 11
26	not previously sampled	near SQS	no data			x		near PCB and hexachlorobenzene SQS exceedances in surface sediment; spatial coverage	na
27	not previously sampled	no data	no data		x	x		geochronology core; spatial coverage	na
28	not previously sampled	near CSL[c]	no data			x		mercury CSL exceedance and PCB SQS exceedance in surface sediment	11 – 14
29	not previously sampled	near CSL	no data		x[d]	x		near PCB and mercury CSL exceedances in surface sediment; spatial coverage	na
30	not previously sampled	no data	no data			x		spatial coverage	na
31	not previously sampled	near SQS[c]	no data			x		near PCB and mercury SQS exceedances in surface sediment; spatial coverage	na
32	1633 (subsurface)	no data	CSL		x[d]	x		provide additional data at location with CSL exceedances for zinc, mercury, and cadmium in 0-to-4-ft core	0 – 14
33	not previously sampled	no data	no data		x	x		geochronology core; spatial coverage	na
34	10263 (surface)	CSL[c]	no data			x		provide additional data at location with mercury CSL exceedance; spatial coverage	na

Subsurface Location ID	Historical Surface or Subsurface Sample Location ID	Considerations for Placing Sampling Locations							Estimated Depth to Lower Alluvium (ft below mudline)[b]
		Sediment Quality		Outfall	Geo-chronology Core	Nature and Extent	Potential MNR Area[a]	Rationale	
		Detected Surface Chemical Exceedances	Detected Subsurface Chemical Exceedances						
35	1662 (subsurface)	no data	CSL			x		provide additional data at location with CSL exceedances for bis(2-ethylhexyl) phthalate and hexachlorobenzene in 0-to-4-ft core	1 – 8
36	not previously sampled	near SQS[c]	no data			x		near PCB and mercury SQS exceedance in surface sediment; spatial coverage	na
37	not previously sampled	no data	no data			x		spatial coverage	na
38	not previously sampled	no data	no data	x		x		spatial coverage in vicinity of Lander CSO and storm drain 29	2 – 7
39	not previously sampled	no data	no data			x		spatial coverage	na
40	1396 (subsurface)	no data	CSL			x		PCB, mercury, and BEHP CSL exceedances in subsurface sediment	1 – 2
41	not previously sampled	near SQS	no data			x		spatial coverage; near PCB SQS exceedance in surface sediment	1.5 – 6
42	not previously sampled	near CSL	near CSL			x		near PCB CSL exceedance in surface sediment; near PCB and mercury CSL exceedances in 0-to-4-ft sediment cores; spatial coverage,	0 – 4
43	not previously sampled	no data	no data			x		spatial coverage	2 – 3
44	not previously sampled	near location with no exceedances	near location with no exceedances			x		spatial coverage near utility crossing	0 – 6

Subsurface Location ID	Historical Surface or Subsurface Sample Location ID	Considerations for Placing Sampling Locations							Estimated Depth to Lower Alluvium (ft below mudline)[b]
		Sediment Quality		Outfall	Geo-chronology Core	Nature and Extent	Potential MNR Area[a]	Rationale	
		Detected Surface Chemical Exceedances	Detected Subsurface Chemical Exceedances						
45	not previously sampled	near SQS	no data			x		spatial coverage, near SQS exceedances in surface sediment for PCBs and acenaphthene	2.3 – 15
46	not previously sampled	no data	no data			x		spatial coverage near utility crossing	0 – 7
47	2141 (surface)	CSL	near SQS			x		PCB CSL exceedance in surface sediment; near mercury SQS exceedance in subsurface sediment; spatial coverage	0 – 5
48	not previously sampled	near SQS	no data			x		near PCB SQS in surface sediment; spatial coverage	3 – 21
49	not previously sampled	no data	no data			x		spatial coverage	0 – 7
50	2135 (surface)	SQS	near CSL			x		mercury and PCB SQS exceedances in surface sediment; near PCB, mercury, BEHP, and multiple individual PAH CSL exceedances in subsurface sediment	0 – 17
51	2134 (surface)	CSL	near CSL			x		PCB CSL exceedance in surface sediment; near PCB and 1,4-dichlorobenzene CSL exceedances in subsurface sediment	0 – 2

Subsurface Location ID	Historical Surface or Subsurface Sample Location ID	Considerations for Placing Sampling Locations							Estimated Depth to Lower Alluvium (ft below mudline)[b]
		Sediment Quality							
		Detected Surface Chemical Exceedances	Detected Subsurface Chemical Exceedances	Outfall	Geo-chronology Core	Nature and Extent	Potential MNR Area[a]	Rationale	
52	not previously sampled	near CSL	near CSL			x		near arsenic CSL exceedance in surface sediment; near PCB, mercury, arsenic, lead, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, and multiple individual PAH CSL exceedances in subsurface sediment	5 – 25
53	not previously sampled	no data	no data			x		spatial coverage	0 – 2
54	2157 (surface)	CSL	near CSL					arsenic CSL exceedance in surface sediment; near PCB, mercury, BEHP, 4-methylphenol, and multiple individual PAH CSL exceedances in subsurface sediment	na
55	not previously sampled	no data	no data			x		spatial coverage	0 – 2
56	2170 (surface)	SQS	none					PCB SQS exceedance in surface sediment;	0 – 4
57	not previously sampled	near SQS and CSL	no data			x		near acenaphthene, fluorene, and phenanthrene CSL exceedances and PCB SQS exceedance in surface sediment	0 – 6
58	not previously sampled	no data	no data			x		spatial coverage	0 – 6
59	not previously sampled	near SQS	no data					near PCB SQS exceedances in surface sediment	0 – 4
60	not previously sampled	near CSL	no data					near acenaphthene CSL exceedance in surface sediment	3 – 12
61	not previously sampled	no data	no data			x		spatial coverage	na
62	not previously sampled	no data	no data			x		spatial coverage	0 – 14

Subsurface Location ID	Historical Surface or Subsurface Sample Location ID	Considerations for Placing Sampling Locations							Estimated Depth to Lower Alluvium (ft below mudline)[b]
		Sediment Quality		Outfall	Geo-chronology Core	Nature and Extent	Potential MNR Area[a]	Rationale	
		Detected Surface Chemical Exceedances	Detected Subsurface Chemical Exceedances						
63	not previously sampled	no data	no data			x		spatial coverage	na
100	not previously sampled	proximate to TBT porewater SL exceedance				x		spatial coverage	na
101	not previously sampled	proximate to TBT porewater SL exceedance				x		spatial coverage	na

[a] The head of the waterway will be evaluated as a potential MNR area. These locations will be sectioned at a finer resolution (Method B) as described in Section 3.1.2).

[b] Available lines of evidence used to estimated depths to native alluvium included adjacent historic cores (as shown in Figures 1a and 1b in Appendix F and historical dredge records). Ranges are provided based on uncertainty associated with these estimates.

[c] Surface sediment data for locations within the Phase 1 removal action boundary were obtained from surface sediment samples collected during recontamination monitoring as well as those collected prior to clean sand placement (i.e., during post-dredge monitoring and pre-sand placement sampling events).

[d] Subsurface samples will be collected with geotechnical core taken at this location.

BEHP – bis(2-ethylhexyl) phthalate

ID – identification

CSL – cleanup screening level

CSO – combined sewer overflow

MNR – monitored natural recovery

na – not available (because of a lack of historical core information)

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

SQS – sediment quality standards

Subsurface cores will be collected to depths of ranging from 4 to 14 ft (2.4 to 4.3 m) below mudline or refusal, whichever is reached first. The core collection depth at each location will be based on the expected depth of native sediment in the vicinity of that location, as evaluated in Appendix F and presented in Table 3-1. Cores will be obtained to the deepest sediment depth practicable. The limiting factors that may control the actual sampling depth include the length of the core tube (14 ft, except for 4-ft cores at Terminal 30 [T-30]) and core refusal. The cores will be examined upon collection, and a determination will be made as to whether native alluvium has been reached. Further examination of the cores during processing may be needed to reach a final determination. EPA will be notified with the results of the determination for each core on a daily basis. There is no assumption that the native alluvium represents pre-industrial material that is not contaminated, and these sediments will be analyzed, if necessary, based on the results for the overlying sediment intervals. Table 3-2 presents the location coordinates for the subsurface sediment sampling locations.

Table 3-2. Subsurface sediment sampling location coordinates

Location	X Coordinate[a]	Y Coordinate[a]	Latitude[b]	Longitude[b]	Estimated Depth Above (+) or Below (-) MLLW (ft)[c]
1	1267032	211459	47.56964	-122.34597	na
2	1267126	211751	47.57045	-122.34561	na
3	1267044	212025	47.5712	-122.34597	na
4	1267343	212070	47.57134	-122.34476	na
5	1267231	212246	47.57181	-122.34523	-12
6	1267396	212537	47.57262	-122.34458	-30
7	1267191	212587	47.57275	-122.34542	-16
8	1267533	212850	47.57349	-122.34405	-36
9	1267756	212976	47.57384	-122.34316	-48
10	1267114	213011	47.5739	-122.34576	-36
11	1267404	213062	47.57406	-122.34459	-38
12	1267225	213429	47.57506	-122.34535	-40
13	1267786	213481	47.57523	-122.34308	-48
14	1267761	213730	47.57591	-122.34320	-50
15	1267156	213760	47.57596	-122.34565	-42
16	1267593	213782	47.57604	-122.34388	-46
17	1267365	213811	47.57611	-122.34481	-44
18	1267204	214045	47.57674	-122.34548	-40
19	1267759	214130	47.57701	-122.34324	-52
20	1267678	214189	47.57716	-122.34357	-52
21	1267769	214348	47.5776	-122.34321	-50
22	1267333	214426	47.57779	-122.34499	-54

Location	X Coordinate[a]	Y Coordinate[a]	Latitude[b]	Longitude[b]	Estimated Depth Above (+) or Below (-) MLLW (ft)[c]
23	1268428	214536	47.57815	-122.34056	-16
24	1267778	214561	47.57819	-122.34320	-48
25	1267556	214621	47.57834	-122.34410	-54
26	1267148	214666	47.57844	-122.34576	-52
27	1268221	214738	47.5787	-122.34142	-26
28	1267507	214901	47.5791	-122.34432	-54
29	1267830	214927	47.57919	-122.34301	-10
30	1268098	215026	47.57948	-122.34193	-46
31	1267287	215034	47.57946	-122.34522	-54
32	1267676	215084	47.57962	-122.34365	-40
33	1267871	215110	47.5797	-122.34286	-32
34	1267416	215363	47.58037	-122.34473	-54
35	1267806	215510	47.58079	-122.34316	-44
36	1267602	215781	47.58152	-122.34401	-54
37	1267215	215783	47.58151	-122.34557	-54
38	1267779	215793	47.58156	-122.34329	-42
39	1267371	216089	47.58235	-122.34497	-54
40	1267408	216466	47.58339	-122.34485	-54
41	1267792	216611	47.58381	-122.34330	-46
42	1267504	216787	47.58427	-122.34448	-54
43	1267235	216832	47.58438	-122.34558	-54
44	1267472	217192	47.58538	-122.34465	-54
45	1267777	217252	47.58556	-122.34341	-46
46	1267210	217355	47.58582	-122.34572	-54
47	1267422	217660	47.58666	-122.34488	-56
48	1267855	217669	47.58671	-122.34313	-34
49	1267431	217970	47.58751	-122.34487	-54
50	1267839	218092	47.58787	-122.34323	-38
51	1267316	218213	47.58817	-122.34536	-58
52	1267874	218317	47.58849	-122.34310	-30
53	1267694	218506	47.589	-122.34385	-54
54	1267907	218620	47.58932	-122.34300	-8
55	1267245	218670	47.58942	-122.34568	-56
56	1267478	218688	47.58948	-122.34474	-56
57	1268204	218890	47.59008	-122.34181	-34
58	1268991	218983	47.59037	-122.33863	-34
59	1268509	218984	47.59035	-122.34059	-36
60	1268052	218994	47.59035	-122.34244	-40

Location	X Coordinate[a]	Y Coordinate[a]	Latitude[b]	Longitude[b]	Estimated Depth Above (+) or Below (-) MLLW (ft)[c]
61	1267826	219053	47.5905	-122.34336	-42
62	1267287	219275	47.59108	-122.34556	-56
63	1267775	219508	47.59175	-122.34360	-52
100					
101					

[a] Coordinates are in Washington State Plane N, NAD83, US ft.

[b] Coordinates are in degrees and decimal minutes, NAD83.

[c] Depth estimated from recent bathymetry data (Windward and DEA 2004).

MLLW – mean lower low water

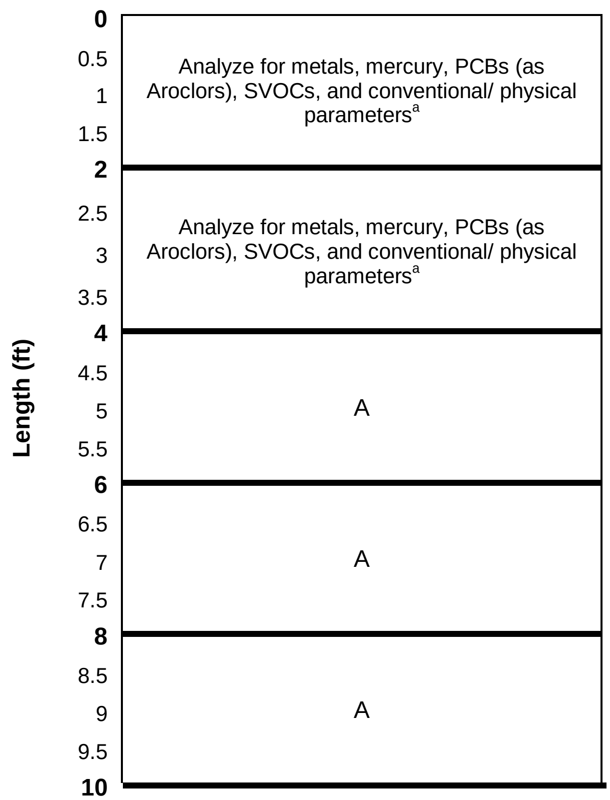
NAD83 – North American Datum of 1983

na – no bathymetry data available at these locations

3.1.2 Sectioning of sediment cores

At each location, single cores will be collected. Collection and processing of sediment cores is discussed in detail in Sections 3.2.3 and 3.2.4, respectively. After processing, each core will be sectioned for chemical and physical analyses according to one of three methods, referred to as Methods A, B, and C. The lengths of the core sections discussed below represent the measurements of actual recovered core lengths rather than *in situ* depths calculated from the bore logs. Core intervals will be divided at 0.5- or 2-ft (15- or 60-cm) intervals, as described below. However, sections may be divided at slightly different intervals if clear discontinuities are identified.

The majority of cores (51 of the 63) will be sectioned into 2-ft intervals according to Method A (Figure 3-1; Map 2-4a). Nine cores (the southernmost cores [SC01 through SC08, SC11]) will be sectioned into 2-ft intervals, and 0.5-ft intervals will also be archived, according to Method B (Figure 3-2; Map 2-4b). The remaining three cores, located in the T-30 dredge prism (SC38, SC41, and SC45), will be sectioned into 1-ft intervals for the top 2 ft, with the lower intervals archived, according to Method C (Figure 3-3; Map 2-4b). Upon review of the preliminary data from the analyzed 1-ft and 2-ft sample intervals along with SMS criteria, EPA and EWG will agree upon selected chemicals for analysis in the archived 0.5-ft intervals or archived deeper intervals, in consultation with the stakeholders. The chemical profile data in the finer-resolution cores (i.e., cores with 0.5-ft sample intervals) will be used to evaluate MNR as a remedial option in the FS.

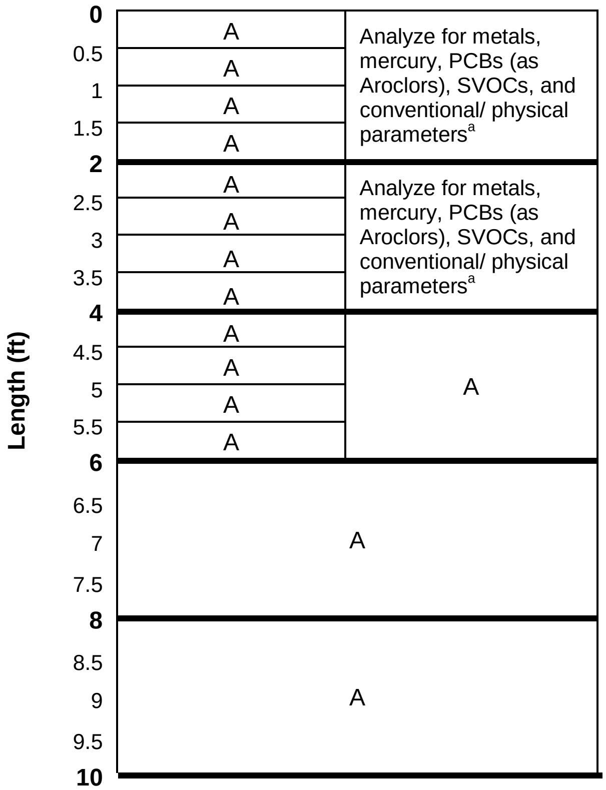


Note: For reference, 1 ft is equal to 30 cm

[a] A subset of samples will be analyzed for physical parameters (Atterberg limits, specific gravity, and bulk density) as described in Section 3.1.3. A subset of samples will also be analyzed for bulk TBT and organochlorine pesticides as described in Section 3.1.3. A subset of samples may be selected for dioxin/furan analysis after the preliminary SRI surface sediment data have been reviewed.

A – Archive for potential chemical analysis of deeper intervals based on results from 0- to-2-ft and 2-to-4-ft intervals. If volume is sufficient in the 2-ft intervals, sediment will also be archived for potential grain size analysis. For cores greater than 10 ft deep, samples from 2-ft intervals below 10 ft will also be archived.

Figure 3-1. Core processing Method A

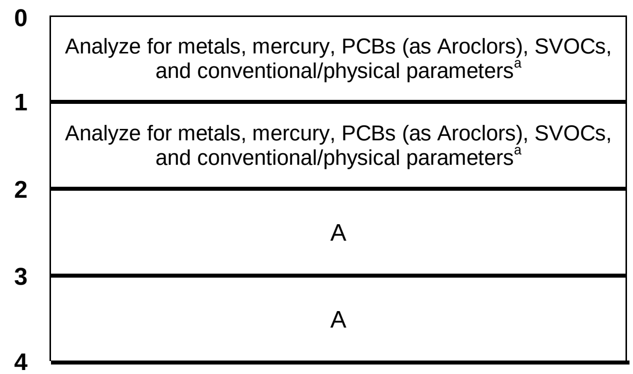


Note: For reference, 1 ft is equal to 30 cm

[a] A subset of samples will be analyzed for physical parameters (Atterberg limits, specific gravity, and bulk density) as described in Section 3.1.3. A subset of samples may be selected for dioxin/furan analysis after the preliminary SRI surface sediment data have been reviewed.

A – Archive for potential analysis of specific chemicals in 0.5-ft intervals or deeper 2-ft intervals, based on results from the 0-to-2-ft and 2-to-4-ft intervals. If volume is sufficient in the 2-ft intervals, sediment will also be archived for potential grain size analysis. For cores greater than 10 ft deep, samples from 2-ft intervals below 10 ft will also be archived.

Figure 3-2. Core processing Method B



[a] A subset of samples will be analyzed for physical parameters (Atterberg limits, specific gravity, and bulk density) as described in Section 3.1.3. A subset of samples may be selected for dioxin/furan analysis after the preliminary SRI surface sediment data have been reviewed.

A – Archive for potential chemical analysis of deeper intervals based on results from 0-to-1-ft and 1-to-2-ft intervals. If volume is sufficient, sediment will also be archived for potential grain size analysis. For cores greater than 4 ft deep, samples from intervals below 4 ft will be archived at 2-ft intervals.

Figure 3-3. Core processing Method C

Method B locations were selected only in the southern portion of the EW where there is a potential for MNR. Sediment deposition is expected to be higher in the area just north of the narrow portion of the EW because of the physical shape of the EW. The conceptual site model for the EW suggests that gross sedimentation may be higher in this area because the increased cross-sectional area causes a substantial reduction in velocity and an associated increase in sedimentation (Anchor and Windward 2008). In addition, gross sedimentation could be higher in the southern portion of the main body of the EW (i.e., north of the bridges) because total suspended solids (TSS) that have settled into the lower water column will have a net flux to the south due to the net southerly velocities near the bottom (Anchor and Windward 2008).

Method C was selected for the three cores in the T-30 dredge boundary because of the recent dredge event in this area. A review of historical bathymetry records suggests that this area is now at its deepest historical depth. Therefore, the native alluvium layer should be attainable using a 4-ft core. The cores will be sectioned into 1-ft intervals to provide a finer resolution for these cores, which may contain a thin layer of recent sedimentation over native material. The first two 1-ft intervals will be analyzed, and the remaining two 1-ft intervals will be archived. Post-dredge monitoring in this area revealed SMS exceedances in the 0-to-10-cm surface sediment samples.

Method A involves sectioning the core into 2-ft intervals and submitting the samples for the first two intervals (0 to 2 and 2 to 4 ft) for initial chemical analyses. Samples collected from the lower depth intervals (4 to 6, 6 to 8, 8 to 10, 10 to 12, and 12 to 14 ft, depending on the depth of the core) will be archived. The selection of archived samples for additional analyses will be agreed upon by EPA and EWG, in consultation with stakeholders, based on preliminary, unvalidated data. Factors that will be considered in selecting archived samples for chemical analyses include the exceedance of SMS criteria or Dredged Material Management Program (DMMP) guidelines in upper intervals or in nearby cores, or the presence of staining/discoloration, sheen, or odor.

For Method B, the uppermost 6 ft of each core will be divided in half lengthwise (Figure 3-2). One of the halves will then be divided horizontally into three 2-ft (60-cm) sections (i.e., 0 to 2, 2 to 4, and 4 to 6 ft), and the other half will be divided into 12 0.5-ft (15-cm) sections. The bottom portion of the core will be divided into 2-ft sections (i.e., 6 to 8, 8 to 10, 10 to 12, and 12 to 14 ft depending on the length of core recovered).

Chemical analyses will initially be conducted on the two 2-ft composite samples from the 0-to-2-ft and 2-to-4-ft intervals. Sediment from 0.5-ft intervals in each core will be archived. These archived samples may be analyzed for a subset of the chemicals analyzed in the 0-to-2-ft and 2-to-4-ft core sections. The specific chemicals that may be analyzed in the archived 0.5-ft intervals will be determined by EPA and EWG, in consultation with stakeholders, based on the preliminary, unvalidated chemistry results in the 0-to-2-ft and 2-to-4-ft intervals. The remaining 2-ft composite samples collected from the lower intervals will also be archived. These samples may be selected for analysis in consultation with EPA based on preliminary, unvalidated data from the upper core intervals.

For Method A, approximately 120 oz of sediment will be available from each 2-ft section. A sample volume of 40 oz is needed for all chemical analyses and 12 oz is needed for all physical analyses (see Section 3.3.1). For Method B, an estimated volume of 15 oz will be available from each 0.5-ft section. Thus, the sediment volumes in the 0.5-ft sections will not be sufficient for the full suite of chemical analyses, but will be sufficient for the analysis of a subset of chemicals where a need for finer scale resolution is indicated by the results from the 2-ft sections. If major discontinuities or contacts are observed visually in the sediment profiles within these 2-ft sections, and the cores are sectioned accordingly, as discussed in Section 3.2.4, it may be necessary to collect more than one core at a particular location to obtain sufficient sediment volume for chemical analyses. The process for collecting and homogenizing additional cores at the same location is discussed in Section 3.2.4. Sampling intervals for the 0.5-ft sections may be adjusted based on the presence of minor discontinuities or contacts in sediment stratigraphy, as described in Section 3.2.4, but the sections will not be divided into intervals of less than 0.5 ft.

3.1.3 Chemical and physical analyses of subsurface sediment samples

Each subsurface sediment sample identified for chemical analyses (except archived samples) will be analyzed for SMS chemicals (SVOCs, PCB Aroclors, mercury, and other metals) using analytical methods presented in Section 3.4. Each subsurface sediment sample (except archived samples) identified for chemical analyses will also be analyzed for TOC, total solids, and grain size. A subset of cores will be analyzed for physical parameters to adequately characterize each stratigraphic unit for geotechnical properties. In approximately 20% of the cores, a sample will be collected from each major stratigraphic unit using a Shelby tube, and will be analyzed for Atterberg limits, specific gravity, and bulk density. The following core locations are targeted for analysis of physical parameters to spatially represent the entire EW: SC05, SC11, SC14, SC20, SC22, SC30, SC36, SC43, SC48, SC51, SC56, SC59, and SC63 (Maps 2-4a and 2-4b). These locations may be changed as necessary if sufficient material is not present in the stratigraphic units of those cores based on core recovery and thickness of each unit.

Samples from locations 22 locations will be analyzed for bulk TBT in sediment. These locations were selected based on surface sediment TBT concentrations and historical subsurface sediment TBT concentrations (Map 3-1). In addition to cores located in areas with elevated surface sediment concentrations along T-18, locations in Slip 27 and Slip 36 were also selected to provide more spatial distribution.

Samples from five locations (locations 11, 19, 39, 54, and 57) will be analyzed for organochlorine pesticides. Organochlorine pesticides have been rarely detected in surface sediment samples (13 detected results from 136 locations) or subsurface sediment samples (30 detected results from 139 analyzed samples). Many of the pesticide detections are the result of analytical interference in the analysis of pesticides because of the presence of PCB congeners. Therefore, there is uncertainty associated with the existing detected pesticide results. The five identified locations were selected because of their spatial distribution and the fact that they had detected DDT concentrations above the SL (Map 3-2).

In addition, samples from a subset of locations will be analyzed for dioxins/furans. Locations for dioxins/furans analyses will be selected based on a review of the preliminary, unvalidated surface sediment data from the March and May 2009 sampling events for the SRI/FS.

3.2 SAMPLING METHODS

This section describes the methods for collecting and processing subsurface sediment cores. Sediment sampling will be conducted at locations shown in Maps 2-2a and 2-2b. All field activities will be performed under the direction of the FC, with EPA oversight as appropriate. The field geologist will lead activities associated with the logging and processing of sediment cores. There may be contingencies during field activities that require modification of the general procedures outlined below. Procedures may be modified at the discretion of the FC after consultation with the Windward PM and the boat operators, if applicable. EPA will be consulted in the event that significant deviations from the sampling design are required (e.g., repositioning of a location, as discussed in Section 3.2.3). All modifications will be recorded in the field logbook and on a protocol modification form (Appendix B).

3.2.1 Identification scheme for all locations and samples

Each subsurface sediment core sampling location will be assigned a unique alphanumeric location ID number. The first four characters of the location ID are "EW" to identify the EW project area, followed by "09" to identify the year in which the sample was collected (i.e., EW09). The next four characters are "SC" to indicate the type of samples to be collected (sediment core), followed by a consecutive number identifying the specific location within the EW (e.g., SC01).

The sample ID will consist of the location ID followed by include a numerical suffix that indicates which depth horizon the sediment sample came from. For example, the sample from the upper 2-ft (60-cm) section of the core collected at location EW09-SC01 will be identified as EW09-SC01-0-2; the 2-to-4-ft (60-to-120-cm) section of sediment from the same core will be identified as EW09-SC01-2-4, and so on. Samples collected at 0.5-ft intervals will be similarly identified; for example, the sample collected from the upper 0.5-ft section of the core collected at location EW09-SC01 will be identified as EW09-SC01-0-0.5. Field duplicate samples will be identified using location numbers starting with 201. For example, the upper 2-ft section of the first field duplicate sample would be identified as EW09-SC201-0-2.

A rinsate blank sample, as described in Section 3.5.1, will be assigned the first four characters of the location ID, followed by "SC" and "RB" (i.e., EW09-SC-RB).

3.2.2 Location positioning

Target sampling locations will be located using a Trimble NT300D differential global positioning system (DGPS). The DGPS includes a global positioning system (GPS) receiver unit onboard the sampling vessel and a US Coast Guard (USCG) beacon differential receiver. The GPS unit will receive radio broadcasts of GPS signals from satellites. The USCG beacon receiver will acquire corrections to the GPS signals to produce positioning accuracy to within 1 to 2 m.

Northing and easting coordinates of the vessel will be updated every second and displayed directly on a computer onboard the vessel. The coordinates will then be processed in real time and stored at the time of sampling using the positioning data management software package. Washington State Plane Coordinates, North, North American Datum of 1983 (NAD83) will be used for the horizontal datum. The vertical datum will be obtained by measuring the depth from the water surface to the mudline at each sampling location using a leadline. This depth will be corrected for tidal influence after sampling has been completed to obtain the depth of the mudline relative to MLLW. Tidal elevation will be determined by calling the National Ocean Service for data from their automated tide gage located at Pier 54.

To ensure the accuracy of the navigation system, a checkpoint will be located at a known point such as a pier face, dock, piling, or similar structure that is accessible by the sampling vessel. At the beginning and end of each day, the vessel will be stationed at the check point, a GPS position reading will be taken, and the reading will be compared with the known land-survey coordinates. The two position readings should agree, within the limits of survey vessel operational mobility, to within 1 to 2 m.

3.2.3 Subsurface sediment core collection

Sediment cores will be collected to targeted depths ranging from 4 to 14 ft (2.4 to 4.3 m) below mudline (depending upon the location) or until refusal, whichever is reached first. Cores will be collected using two methods. Most of the cores will be collected with a vibracorer. However, a subset of cores (i.e., SC01 through SC08 from the narrow southern portion of the site and SC11) will be collected with a MudMole™. The MudMole™ sampler will be used at those locations because the cores will be sampled using Method B, which has 0.5-ft sampling intervals, so the larger core is needed to obtain sufficient sample size for chemical analyses. The vibracorer will more easily penetrate the consolidated material likely to be encountered in the main channel of the EW.

3.2.3.1 Vibracore sampling

The vibracorer consists of a vibrating power head attached a 14-ft-long, 3.75-in.-diameter core barrel. Once the sampling vessel is positioned at the target sampling location, the vibracorer and a decontaminated core tube is lowered using a hydraulic winch. The core is penetrated to the targeted depth or until refusal, and then pulled up using the winch. Once on board the vessel, the depth of core penetration is measured and recorded (i.e., the total core length minus the void space within the core). The following data will be recorded on the sediment core collection log (Appendix B):

- Sampling location, time, tide, and depth of water to sediment (as measured by leadline)
- Elevation of location as estimated from MLLW using tide tables
- Location coordinates from DGPS
- Names of field personnel collecting and handling the cores
- Observations made during core collection, including weather conditions, complications, ship traffic, and other details associated with the sampling effort
- Physical description of core tube (e.g., intact, bent, full core-catcher)
- Length and depth intervals of each core section and estimated recovery for each sediment sample as measured from MLLW

- Qualitative notation of apparent resistance of sediment column to coring (how the core drove)
- Any deviation from the approved QAPP

3.2.3.2 MudMole™ sampling

The MudMole™ sampler consists of a 4-in by 4-in square aluminum core tube with a pneumatic powered driving assembly attached to the top with a quick release pin.[2] The core sampler uses the impact from the linear pneumatic hammer delivering approximately 300 blows per minute to drive the core tube into the sediment. The bottom of each core tube will be fitted with a hinged core catcher to prevent loss of the sediment during extraction. Air to operate the pneumatic corer will be provided by an industrial air compressor located on the deck of the sampling vessel.

At each target sampling location, the MudMole™ will be lowered to the bottom using a winch. At approximately 2-foot intervals, the operator will suspend the driving operation and a scuba diver will measure the penetration depth of the core tube and internal recovery of the core (total core length minus the void space within the core). During diver operations, the penetration and recovery readings are relayed to the sampling vessel by means of a wireless underwater diver communication system. After driving the core to the targeted depth or refusal, the air hammer will be turned off. The final set of penetration and recovery measurements will be made, the actual sampling position will be logged, and the lifting winch will be used to extract the core.

The paired penetration and recovery measurements from the MudMole™ are used to account for thinning and compaction of the sediments during driving. An on-deck measurement from the top of the core tube to the surface of the sediment within the core tube will also be taken to account for any movement or loss of sediment in the core tube as the core catcher closes during extraction. The penetration and recovery data and the on-deck top-of-sediment measurement will be entered into a spreadsheet program to generate a bore log (Appendix B). Each bore log will include a graph of penetration versus recovery that will be used during processing to identify the *in situ* depth of different sediment horizons, as shown in the example bore log in Appendix B.

Once onboard the sampling vessel, the core catcher will be inspected for signs of sediment loss during retrieval and the average percent recovery will be estimated for each core. The average percent recovery is estimated as the sample length recovered divided by the penetration depth. Data will be recorded on the sediment core collection log (Appendix B), as described for the vibracorer in Section 3.2.3.1.

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[2] The inside measurements of this tube are 3.75 in by 3.75 in.

3.2.3.3 On-deck core processing

For both the vibracorer and MudMole™ coring methods, the core tubes will be inspected for adherence to the following criteria:[3]

- Core was collected to the targeted depth below mudline
- Core tube is not overfilled
- Overlying water is present and the surface interval is intact
- Estimated recovery is greater than 75%, and the core tube appears intact without obstructions or blocking

If sample acceptance criteria are not achieved in the first core at a sampling location, the sample will be set aside and up to two additional core drives will be advanced at locations within 10 m of the targeted location. If sample acceptance criteria are not achieved in any of the three cores, oversight personnel will be consulted to discuss whether an alternative location should be sampled. The sampling location may be repositioned at a location greater than 10 m from the targeted location, following discussions with EPA and EWG representatives. If an alternative location is not selected, the core with the greatest sampling depth and recovery will be used.

While the core tube is on deck, the overlying water will be siphoned off, if necessary, using plastic tubing or a similar siphoning device. The vibracore tubes will be cut off near the sediment surface. Cores collected using the vibracorer will be cut into 5-ft sections so they can be transported to the laboratory in a vertical position, if possible, and so they will fit in the refrigeration units at the laboratory until processing. The intact core or core sections will be capped, taped, and labeled with the station ID and "top" and "bottom." The vibracore tubes will be reconstructed during core processing by lining up the labeled sections as appropriate. The Mudmole™ tubes cannot be cut and, because of their length, will be transported horizontally and stored cool or on ice until they can be processed in the order in which they were collected. Core tubes will be sealed to minimize loss of moisture and transported to ARI for subsequent processing, sampling, and logging.

3.2.4 Subsurface sediment core processing

Core tubes will be handled and processed at ARI by Windward and Anchor QEA as soon as possible after they are received. Cores will be handled in a manner consistent with ASTM procedures (ASTM D 4220). Cores that are not processed within 4 hours will be stored upright (if possible) in the ARI refrigerators (i.e., vibracores) or stored cool or on ice in a horizontal position (i.e., MudMole™ cores). Cores may be held for a maximum of 72 hours before processing. Core processing will involve three basic

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[3] An additional criterion is that the core reaches native sediment, which will be determined after the core is opened as described in Section 3.2.4.

steps: 1) core cutting, 2) observation and logging, and 3) sampling. The field geologist will oversee the sediment core processing activities.

Sediment from the vibracorer and MudMole™ cores will be cut for logging and sampling by removing the core caps and cutting the core tube longitudinally with a circular saw. The core will be split into two halves with decontaminated stainless steel wire core splitters or spatulas. If the core was divided into sections for easier transport, this step will be repeated for each section until the entire core is extracted.

After the core has been cut open, sediment will first be observed to determine whether native sediment was reached using the description of density, color, and sediment type described for Lower (Native) Alluvium in Appendix F. If it is determined by the field geologist that native sediment was not reached based on the absence of expected characteristics of the Lower Alluvium at the base of the core, then an attempt will be made to collect a deeper core at that location during this sampling event.

The profile of the accepted core for each location will be visually logged for major and minor contacts (i.e., regions in the core where sediment characteristics noticeably change), as described below. A portable photoionization detector (PID) will be used to determine the potential presence of volatile organic compounds (VOCs) in the core. Photographs of each core will be taken before sampling. The core will be logged by a field geologist or geotechnician, and recorded on the sediment core processing log (presented in Appendix B).

Each core will be sub-sectioned into 2-ft sampling intervals according to the sampling design discussed in Section 3.1 of this document unless a major stratigraphic boundary is present. If a major difference in stratigraphic units is observed, the sample will not be collected at the fixed 2-ft interval, but will instead include only sediments within the same stratigraphic unit. Chemical releases to sediment may have been associated with different historical periods as indicated by the sediment stratigraphy, so it is desirable to separate the chemical analyses for the different units. The sectioning decision for each core will be made by the field geologist, in consultation with EPA oversight if present at the time the core is sectioned. For cores processed using Method B as described in Section 3.1, the uppermost 6 ft of half of the core will be sub-sectioned into 0.5-ft sampling intervals (see Figure 3-2). These sampling intervals may be adjusted to maintain consistency in color and grain size within each sample, or based on the presence of odor, sheen, or debris. However, the size of the sampling interval will not be less than 0.5 ft in order to obtain sufficient volume of sediment for chemical analyses. Sediment descriptions and the interpreted *in situ* depths of each sediment horizon (derived from calculations on the bore log) will be recorded on the sediment core processing log (Appendix B). Data recorded on the core processing logs will include:

- Sample recovery

- Physical soil description in accordance with ASTM procedures (ASTM D 2488 and ASTM D 2487 - Unified Soil Classification System) including soil type, density/consistency of soil, and color
- Odor (e.g., hydrogen sulfide, petroleum)
- Visual stratification, structure, and texture
- Vegetation and debris (e.g. woodchips or fibers, paint chips, concrete, sand blast grit, metal debris
- Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
- Presence of oil sheen
- PID results for potential presence of VOCs

After a core is logged, sediment from designated sampling intervals in that core will be spooned into stainless steel bowls, homogenized until uniform in color and texture, and placed into pre-cleaned, labeled glass jars for chemical analyses, as specified in Section 3.3.1. Care will be taken not to include sediment that has been in contact with the core sidewalls, caps, or Shelby tube. In cores collected from the Phase 1 removal area, which was covered with a clean sand layer, samples will only be collected below the top sand layer (i.e., the 0-to-2-ft interval will begin at the bottom of the sand layer; see Figure 3-4). This sand layer will be identified and documented by the field geologist using best professional judgment. The layer of sediment that has been deposited on the surface since the sand layer was placed was recently characterized as part of the recontamination monitoring conducted following the placement of the sand layer (Windward 2008). Organisms and debris will be removed prior to distribution to sample containers; removed materials will be noted in the field logbooks. All sample containers will be labeled on the outside in indelible ink with the sample ID number, date collected, and analysis to be performed.

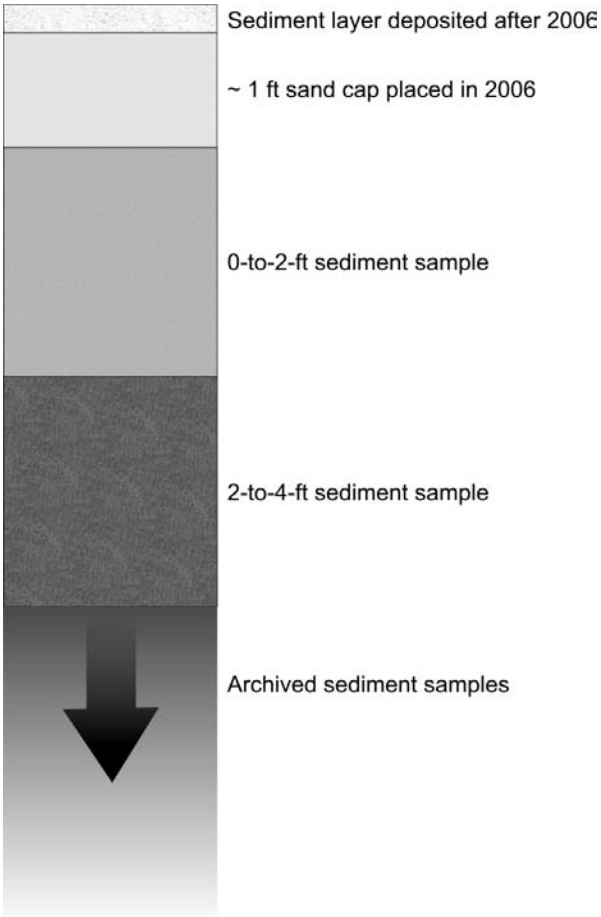

Figure 3-4. Location of subsurface sediment samples within cores to be collected from the Phase 1 removal area

3.2.5 Field sampling and processing equipment

The items needed in the field for subsurface sediment sampling and sample processing are identified in Table 3-3. The FC will check that all equipment is included and in working order each day before sampling personnel go in the field. As part of the mobilization process, each item will be double-checked by the FC.

Table 3-3. Subsurface sediment collection and processing equipment

General Equipment	
QAPP	Cellular phone
Key personnel contact information list	Digital camera
Field sample collection forms	First aid kit
Field notebooks (Rite in the Rain®)	Garbage bags
Chain-of-custody forms	Paper towels
Pens, pencils, Sharpies®	Tape measure
Powder-free nitrile exam gloves	
Field-Collection Equipment	**Sample-Processing Equipment**
Tide tables	Saw for cutting aluminum core tubes
Study area maps	Stainless-steel plates, spatulas, bowls, and spoons
Hard hats	Sample jars
Head lamps	Sample labels
Personal flotation devices (PFDs)	Clear packing tape
Raingear	Custody seals
Rubber work gloves	Alconox® detergent
Safety glasses, sun glasses	Scrub brushes
Steel-toe boots	Distilled water
Core tubes	Heavy duty aluminum foil
Duct tape	Ziplock bags
Plastic tubing/turkey basters (to siphon overlying water)	Coolers
	Cooler temperature blanks
	Ice (wet)
	Flashlights and temporary work lights
	Safety glasses

3.2.6 Decontamination procedures

All sediment processing and homogenizing equipment used during core sampling at ARI (i.e., stainless steel plates, spatulas, bowls, and spoons), will be decontaminated between sampling locations following Puget Sound Estuary Program (PSEP) guidelines (1997) and the following procedures:

1. Rinse with tap water and wash with a scrub brush until free of sediment.
2. Wash with phosphate-free detergent.
3. Rinse with tap water.
4. Rinse with 10 percent HNO_3
5. Rinse with distilled water.
6. Rinse with methanol.
7. Rinse with distilled water.

Any sampling equipment that cannot be cleaned to the satisfaction of the FC and EPA (if present) will not be used for further sampling activities.

3.2.7 Waste disposal

All disposable sampling materials and personal protective equipment used during core collection in the field, such as disposable coveralls, gloves, and paper towels, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal as solid waste. Excess sediment remaining after core processing at ARI will be placed in drums and disposed in an appropriate manner using the procedures outlined in ARI's Chemical Hygiene Plan. Drums will be properly labeled, kept closed, and stored separately from other incompatible wastes (e.g., liquid solvents). Windward will ensure that all drums are properly transported and disposed.

3.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

This section describes how individual samples will be processed, labeled, tracked, stored, and transported to the laboratory for analysis. In addition, this section describes sample custody procedures and shipping requirements. Sample custody is a critical aspect of environmental investigation. Sample possession and handling must be traceable from the time of sample collection through laboratory analyses until Windward authorizes sample disposal.

3.3.1 Sample handling procedures

Sediment samples for chemical analyses will be placed in appropriately sized, pre-cleaned, labeled, wide-mouth glass jars and capped with Teflon®-lined lids (Table 3-4). All sediment sample containers will be filled leaving a minimum of 1 cm of headspace to prevent breakage during shipping and storage.

Table 3-4. Sample containers and laboratories conducting chemical analyses

PARAMETER	CONTAINER	LABORATORY
Sediment Samples		
PCBs (as Aroclors), organochlorine pesticides, SVOCs, SVOCs by SIM	16-oz glass jar	ARI
Bulk TBT, metals, TOC, and total solids	8-oz glass jar	ARI
Grain size	16-oz glass jar[a]	ARI
Dioxins/furans	8-oz glass jar	Analytical Perspectives
Archive	8 or 16-oz glass jars	ARI
Bulk density, Atterberg limits, and specific gravity	3-inch diameter Shelby tube[b]	ARI
Aqueous Samples (rinsate blanks)		
PCBs (as Aroclors), organochlorine pesticides, SVOCs, SVOCs by SIM, TBT	6 500-mL glass amber jars	ARI
Metals	500-mL HDPE jar	ARI

a Sediment archived for potential grain size analysis will be stored in 16-oz HDPE or glass jars.

b Approximately 12 oz of sediment is needed for this sample, including the extra sample surrounding the tube that cannot be used for analysis because it has been in contact with the tube.

ARI – Analytical Resources, Inc.
HDPE – high-density polyethylene
PCB – polychlorinated biphenyl
SVOC – semivolatile organic compound
TOC – total organic carbon

Sample labels will be waterproof and self-adhering. Each sample label will contain the project name, sample ID, preservation technique, type of analysis, date and time of collection, and initials of the person(s) preparing the sample. A completed sample label will be affixed to each sample container. The labels will be covered with clear tape immediately after they have been completed to protect them from being stained or spoiled from water and sediment.

3.3.2 Sample custody procedures

Samples are considered to be in custody if they are: 1) in the custodian's possession or view, 2) retained in a secured place (under lock) with restricted access, or 3) placed in a container and secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s). Custody procedures will be used for all cores and samples throughout the collection, transport, and analytical process. Custody procedures will be initiated during sediment core collection. COC forms will accompany cores when they are delivered by the field crew to Windward and Anchor QEA personnel for processing at ARI, and separate forms will then accompany the processed samples during transfer to ARI personnel at the laboratory or during delivery to Analytical Perspectives. Each person who has custody of the cores or samples will sign the COC form and ensure that the cores or samples are not left unattended unless properly secured. Minimum documentation of core or sample handling and custody will include:

- Project name and unique core or sample number
- Core or sample collection date and time
- Any special notations on core or sample characteristics or problems
- Initials of the individual collecting the core or sample
- Date core or sample was sent to the laboratory
- Shipping company name and waybill number, if applicable

The FC will be responsible for all sample tracking and custody procedures for sediment cores in the field. The FC will be responsible for final sample inventory and will maintain sample custody documentation. At the end of each day, and prior to transfer of sediment cores and sediment samples to the laboratory, COC entries will be made for all cores and samples. Information on the labels will be checked against sample log entries, and sample tracking forms and samples will be recounted. COC forms will accompany all cores and samples. The COC forms for the sediment cores will be signed at the point of transfer from the field to the laboratory, and the COC forms for the sediment samples will be signed at the point of transfer from Windward and QEA personnel to ARI personnel. Copies of all COC forms will be retained and included as appendices to QA/QC reports and data reports. After sediment core processing, the sediment samples will be hand delivered to ARI or shipped in sealed coolers to Analytical Perspectives. The FC will ensure that the laboratory has accepted delivery of the shipment at the specified time.

The laboratories will ensure that COC forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity on the COC forms. The laboratories will contact the FC or the project QA/QC coordinator immediately if discrepancies between the COC forms and the sample shipment upon receipt are discovered.

At each laboratory, a unique sample identifier will be assigned to each sample. The laboratory will ensure that a sample tracking record follows each sample through all stages of laboratory processing. The sample tracking record must contain, at a minimum, the name/initials of individuals responsible for performing the analyses, dates of sample extraction/preparation and analysis, and the type of analysis being performed. The laboratories will not dispose of the environmental samples for this project until notified in writing by the project QA/QC coordinator.

3.3.3 Shipping requirements

Sample processing (i.e., collection of sediment samples from the subsurface sediment cores) will be conducted at ARI. Sediment cores will be stored on ice or refrigerated until delivery to ARI. All sediment chemical analyses, except analysis of dioxins and furans, will be performed at ARI. Samples for analysis at ARI will be directly transferred to the custody of ARI. Samples for analysis of dioxins and furans will be stored frozen at ARI. At the end of the sampling event, these samples will be wrapped in bubble wrap, placed in a cooler containing bagged wet ice or frozen gel packs, and shipped to Analytical Perspectives via overnight shipping. The temperature inside the cooler(s) containing sediment samples will be checked upon receipt at the laboratory by either measuring the temperature of blank water samples packed inside the cooler, or using an infrared (IR) device. The laboratory will specifically note if the cooler is not sufficiently cold (4° ± 2°C) upon receipt.

3.4 Analytical Methods

This section discusses standard methods and DQIs for chemical analyses. A summary of the analyses to be conducted is presented in Table 3-5.

Table 3-5. Procedures to be conducted at each analytical laboratory

ARI	Analytical Perspectives
PCB Aroclors SVOCs (including PAHs and low level SVOCs by SIM) Metals including mercury TOC, total solids, and grain size Organochlorine pesticides (subset of samples) Butyltins (subset of samples) Atterberg limits, bulk density, specific gravity	Dioxins and furans (subset of samples)

ARI – Analytical Resources, Inc.
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SIM – selected ion monitoring
SVOC – semivolatile organic compound
TOC – total organic carbon

3.4.1 Laboratory methods and sample handling

All samples (except archived samples) will be analyzed for PCB Aroclors; SVOCs; total metals, including mercury; grain size; total solids; and TOC. A subset of samples will be analyzed for organochlorine pesticides, butyltins, and dioxins/furans.

In addition to the analyses specified, additional sediment from each sample will be archived frozen at ARI in the event that additional chemical analyses are necessary. Analytical methods and sample handling requirements are presented in Table 3-6.

Table 3-6. Laboratory analytical methods and sample handling requirements for sediment samples

Parameter	Method	Reference	Sample Holding Time[a]	Preservative
PCBs as Aroclors	GC/ECD	EPA 8082	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
Dioxins and furans	HRGC/HRMS	EPA 1613B	1 year to extract, 40 days to analyze	freeze/-20 °C
Organochlorine pesticides[c]	GC/ECD	EPA 8081A	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
SVOCs (including PAHs)[d]	GC/MS	EPA 8270D	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
Selected SVOCs[e]	GC/MS-SIM	EPA 8270D-SIM	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
Mercury	CVAA	EPA 7471A	28 days[f]	cool/0 – 6 °C
Other metals[g]	ICP-AES or ICP-MS	EPA 6010B or EPA 200.8	6 months	cool/0 – 6 °C
Tributyltin, dibutyltin, monobutyltin (as ions)	GC/FPD	Krone et al. (1989)	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
Grain size[h]	sieve/pipette	PSEP (1986)	6 months	cool/0 – 6 °C
TOC	combustion	Plumb (1981)	14 days[f]	cool/0 – 6 °C
Total solids	oven-dried	PSEP (1986)	7 days[f]	cool/0 – 6 °C
Atterberg limits	sieve	ASTM D4318	none	none

PARAMETER	METHOD	REFERENCE	SAMPLE HOLDING TIME[a]	PRESERVATIVE
Specific gravity	pycnometer	ASTM D854	none	none
Bulk density	volumetric/ gravimetric	ASTM D2937	none	none

[a] All samples will be archived frozen at the laboratory until the Windward PM authorizes their disposal.

[b] Sediment can also be frozen to increase the holding time to 1 year extraction. Aqueous rinsate blanks have a maximum holding time of 7 days to extract and 40 days to analyze and will be stored at 0 to 6 °C.

[c] Target pesticides include: 4,4′-DDT, 4,4′-DDE, 4,4′-DDD, 2,4′-DDT, 2,4′-DDE, 2,4′-DDD, aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC, oxychlordane, alpha- and gamma-chlordane, cis- and trans-nonachlor, dieldrin, endosulfan, endosulfan sulfate, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor, mirex, and toxaphene. Detected pesticides may be confirmed by EPA 1699 (modified) using GC/MS/MS.

[d] Target PAHs include: anthracene, pyrene, dibenzofuran, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, fluoranthene, benzo(k)fluoranthene, acenaphthylene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, benz(a)anthracene, acenaphthene, phenanthrene, fluorene, 1-methylnaphthalene, naphthalene, and 2-methylnaphthalene.

[e] Selected SVOCs include: 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 2,4-dimethylphenol, 2-methylphenol, benzyl alcohol, butyl benzyl phthalate, dibenz(a,h)anthracene, di-methyl phthalate, hexachlorobenzene, hexachlorobutadiene, n-nitrosodimethylamine, n-nitrosodiphenylamine, n-nitrosodi-n-propylamine, and pentachlorophenol.

[f] Sediment may be frozen, with a maximum holding time of 6 months.

[g] Sediment may be frozen, with a maximum holding time of 1 year. Aqueous rinsate blanks will be preserved with nitric acid. Metals include arsenic, antimony, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc.

[h] Grain size intervals include gravel: fractional % phi >-1 (> 2,000 microns); sand: fractional % phi -1 to 0 (1,000 to 2,000 microns), fractional % phi 0 to 1 (500 to 1,000 microns), fractional % phi 1 to 2 (250 to 500 microns), fractional % phi 2 to 3 (125 to 250 microns), fractional % phi 3 to 4 (62.5 to 125 microns); silt: fractional % phi 4 to 5 (31.2 to 62.5 microns), fractional % phi 5 to 6 (15.6 to 31.2 microns), fractional % phi 6 to 7 (7.8 to 15.6 microns), fractional % phi 7 to 8 (3.9 to 7.8 microns); clay: fractional % phi 8 to 9 (1.95 to 3.9 microns), fractional % phi 9 to 10 (0.98 to 1.95 microns), fractional % phi 10+ (< 0.98 micron).

BHC – benzene hexachloride

CVAA – cold vapor atomic absorption

GC/ECD – gas chromatography/electron capture detection

GC/FPD – gas chromatography/flame photometric detection

GC/MS – gas chromatography/mass spectrometry

GC/MS/MS – gas chromatography/mass spectrometry/mass spectrometry

HRGC/HRMS – high-resolution gas chromatography/high-resolution mass spectrometry

ICP-AES – inductively coupled plasma-atomic emission spectrometry

ICP-MS – inductively coupled plasma-mass spectrometry

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

PSEP – Puget Sound Estuary Program

SIM – selected ion monitoring

SVOC – semivolatile organic compound

TOC – total organic carbon

3.4.2 Data quality indicators

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. Table 3-7 list specific DQIs for the laboratory analyses of all samples. Target MDLs and RLs are presented in

Appendix C. ARI's QC limits are in Appendix H. These parameters are discussed in greater detail in the following sections.

Table 3-7. Data quality indicators for sediment analyses

Parameter	Precision (Laboratory Replicates)	Accuracy		Completeness
		Instrument Calibration (% Difference)[a]	Spiked Samples (% Recovery)	
PCBs as Aroclors	±50%	±25	laboratory QC limits[b]	95%
Organochlorine pesticides	±50%	±25	laboratory QC limits[b]	95%
SVOCs (including PAHs and low-level SVOCs by SIM)	±50%	±25	laboratory QC limits[b]	95%
Dioxins and furans	±50%	±25	laboratory QC limits[b]	95%
Mercury	±30%	±20	75 – 125	95%
Other metals	±30%	±10	75 – 125	95%
Butyltins	±50%	±15	laboratory QC limits[b]	95%
TOC	±30%	na	laboratory QC limits[b]	95%
Grain size	±30%	na	na	95%
Total solids	±20%	na	na	95%
Bulk density	na	na	na	95%
Atterberg Limits	na	na	na	95%
Specific gravity	na	na	na	95%

a Limits set according to EPA functional guidelines for data validation (EPA 2004, 1999).

b The laboratory's performance-based control limits that are in effect at the time of analysis will be used as accuracy limits for LCS, MS/MSD, and ongoing precision and accuracy samples; therefore, the QC limits presented in Appendix H may be rendered obsolete if new QC limits are established by the laboratory. The laboratory QC limits may be updated at the laboratory's discretion.

LCS – laboratory control sample
MS – matrix spike
MSD – matrix spike duplicate
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
QC – quality control
SIM – selected ion monitoring
SVOC – semivolatile organic compound
TOC – total organic carbon

3.4.2.1 Precision

Precision is the measure of the reproducibility among individual measurements of the same property, usually under similar conditions, such as multiple measurements of the same sample. Precision is assessed by performing multiple analyses on a sample and is expressed as an RPD when duplicate analyses are performed and as %RSD when more than two analyses are performed on the same sample (e.g., triplicates). Precision is assessed through laboratory duplicate analyses (i.e., laboratory replicate samples, MS/MSD, LCS duplicates) for all parameters except when reference materials are not available or spiking of the matrix is inappropriate. In these cases, precision is assessed through laboratory triplicate analyses. Precision measurements can be affected by the nearness of a chemical concentration to the MDL, where the percent error (expressed as either %RSD or RPD) increases. The DQI for precision varies depending on the analyte (Table 3-7). The equations used to express precision are as follows:

$$RPD = \frac{(\text{measured conc} - \text{measured duplicate conc})}{(\text{measured conc} + \text{measured duplicate conc}) \div 2} \times 100$$

$$\%RSD = (SD/D_{ave}) \times 100$$

where:

$$SD = \sqrt{\left(\frac{\left(\sum Dn - D_{ave} \right)^2}{(n-1)} \right)}$$

D	=	sample concentration
D_{ave}	=	average sample concentration
n	=	number of samples
SD	=	standard deviation

3.4.2.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Accuracy may be expressed as a percentage recovery for MS, LCS, and ongoing precision and accuracy sample analyses. The DQI for accuracy varies, depending on the analyte (Table 3-7). The equation used to express accuracy for spiked samples is as follows:

$$\text{Percent recovery} = \frac{\text{spike sample result} - \text{unspiked sample result}}{\text{amount of spike added}} \times 100$$

3.4.2.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. The sampling approach was designed to address the specific objectives described in Section 2.2. Assuming those objectives are met, the samples collected should be considered adequately representative of the environmental conditions they are intended to characterize.

3.4.2.4 Comparability

Comparability expresses the confidence with which one dataset can be evaluated in relation to another dataset. Sample collection and chemical and physical testing will adhere to the most recent PSEP QA/QC procedures (PSEP 1997b) and EPA and PSEP analysis protocols.

3.4.2.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

$$\text{Completeness} = \frac{\text{number of valid measurements}}{\text{total number of data points planned}} \times 100$$

The DQI for completeness for all components of this project is 95%. Data that have been qualified as estimated because the QC criteria have not been met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

3.4.2.6 Sensitivity

Analytical sensitivity is a measure of both the ability of the analytical method to detect the analyte and the concentration that can be reliably quantified. The minimum concentration of the analyte that can be detected is the MDL. The minimum concentration that can be reliably quantified is the RL. Laboratories use both MDLs and RLs for reporting analyte concentrations, and both values will be used as measures of sensitivity for each analysis.

The MDL is defined as the lowest concentration of an analyte or compound that a method can detect in either a sample or a blank with 99% confidence. ARI determines MDLs using standard procedures outlined in 40 CFR 136, in which seven or more replicate samples are fortified at 1 to 5 times (but not to exceed 10 times) the expected MDL concentration. The MDL is then determined by calculating the standard deviation of the replicates and multiplying by the Student's t-factor (e.g., 3.14 for seven replicates). Analytical Perspectives calculates an estimated detection limit, which is generally 3 times the method blank concentration. The laboratories must submit an initial demonstration of MDLs to EPA prior to sample collection.

RLs are equal to or greater than the lower calibration limit defined by the lowest concentration on the calibration curve. RLs, MDLs, and estimated detection limits are adjusted for each sample based on the amount of sample extracted, dilution factors, and percent moisture.

All laboratories will report detected concentrations above the RL without qualification and will report detected concentrations between the MDL (ARI) or estimated detection limit (Analytical Perspectives) and the RL with a J-qualifier indicating the concentration is an estimated value. The estimated detection limit calculated by Analytical Perspectives is a sample-specific detection limit based on the signal to noise ratio at the time of sampling. Non-detect results will be reported to the RL with a U-qualifier. The target RLs and MDLs are presented in Appendix C.

3.5 QUALITY ASSURANCE/QUALITY CONTROL

The QA/QC criteria for the field and laboratory analyses are described below.

3.5.1 Field QC samples

Field duplicate samples will be collected to evaluate the variability attributable to sample homogenization and subsequent sample handling. Field duplicate samples will be collected from the same homogenized material as the original sample and analyzed as a separate sample; this type of field QA/QC sample is also referred to as a field split sample (PSEP 1997). A minimum of one field duplicate sample will be analyzed for every 20 samples. Field duplicate analyses will only be performed on samples collected from 2-ft intervals, unless there is sufficient material to also conduct analyses on samples collected from 0.5-ft intervals.

In addition, a single rinsate blank sample will be collected by rinsing laboratory distilled water over the sample homogenization equipment. The rinsate blank sample will be analyzed for PCB Aroclors, organochlorine pesticides, SVOCs, mercury, other metals, and butyltins.

Although data validation guidelines have not been established for field QC samples, the data resulting from the analyses of these samples will be useful in identifying possible problems resulting from sample collection or sample processing in the field. All field QC samples will be documented in the field logbook and verified by the project QA/QC coordinator or a designee.

3.5.2 Chemical analyses QC criteria

Before analyzing the samples, the laboratory must provide written protocols for the analytical methods to be used, calculate MDLs for each analyte in each matrix type, and establish an initial calibration curve for all analytes. The laboratory must demonstrate their continued proficiency through participation in inter-laboratory comparison studies and through repeated analyses of SRMs, calibration checks, method blanks, and spiked samples.

3.5.2.1 Sample delivery group

Project- and/or method-specific QC measures such as MS/MSD or laboratory replicate samples will be analyzed per sample delivery group (SDG), preparatory batch, or analytical batch, as specified in Table 3-8. An SDG is defined as no more than 20 samples or a group of samples received at the laboratory within a 2-week period. Although an SDG may span 2 weeks, all holding times specific to each analytical method will be met for each sample in the SDG.

Table 3-8. Quality control sample analysis summary

Analysis Type	Initial Calibration	Second Source Initial Calibration Verification	Continuing Calibration Verification	Laboratory Control Sample[a]	Laboratory Replicate Sample	Matrix Spike	Matrix Spike Duplicate	Method Blank	Standard Reference Material	Surrogate Spike
PCB Aroclors	prior to analysis	after initial calibration	every 10 to 20 analyses or 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each batch or SDG	each sample
Dioxins/furans	prior to analysis	after initial calibration	prior to 12-hour analytical batch	1 per prep batch[a]	na	na	na	1 per prep batch	na	each sample
Organochlorine pesticides[b]	prior to analysis	after initial calibration	every 10 to 20 analyses or 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each batch or SDG	each sample
Metals including mercury	daily	after initial calibration	every 10 samples	1 per prep batch	1 per batch or SDG	1 per batch or SDG	na	1 per prep batch	each batch or SDG	na
SVOCs, including PAHs and low-level SVOCs by SIM	prior to analysis	after initial calibration	every 10 to 20 analyses or 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each batch or SDG	each sample
Butyltins	prior to analysis	after initial calibration	every 10 samples or 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each batch or SDG	each sample
Grain size	na	na	na	na	2 per batch or SDG	na	na	na	na	na
TOC	daily	after initial calibration	every 10 samples	1 per prep batch	1 per batch or SDG	1 per batch or SDG	na	1 per prep batch	na	na
Percent solids	na	na	na	na	1 per batch or SDG	na	na	1 per prep batch	na	na
Atterberg limits	na	na	na	na	na	na	na	na	na	na
Specific gravity	na	na	na	na	na	na	na	na	na	na
Bulk density	na	na	na	na	na	na	na	na	na	na

Note: A batch is a group of samples of the same matrix analyzed or prepared at the same time, not to exceed 20 samples.

[a] An OPR sample functions as a laboratory control sample to assess the accuracy of the analysis of dioxins/furans. Duplicate OPR samples may be used to assess the precision of the analysis of dioxins/furans.

[b] Aroclor standards will be run as interference check samples for this analysis.

na – not applicable

OPR – ongoing precision and recovery

PCB – polychlorinated biphenyl

PAH – polycyclic aromatic hydrocarbon

SDG – sample delivery group

SIM – selected ion monitoring

SVOC – semivolatile organic compound

TOC – total organic carbon

3.5.2.2 Laboratory QC criteria

The laboratory analysts will review the results of QC analyses of each analytical batch (described below) immediately after the samples have been analyzed. The QC sample results will be evaluated to determine whether control limits have been exceeded. If control limits are exceeded, then appropriate corrective action must be initiated before a subsequent group of samples can be processed (e.g., recalibration followed by reprocessing of the affected samples). The project QA/QC coordinator must be contacted immediately by the laboratory PM if satisfactory corrective action to achieve the DQIs outlined in this QAPP is not possible. All laboratory corrective action reports relevant to the analysis of project samples must be included in the data deliverable packages.

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology, Environmental Resource Associates, National Research Council of Canada, or other documented, reliable commercial sources. The accuracy of the standards should be verified through comparison with an independent standard. Laboratory QC standards are verified a multitude of ways. Second-source calibration verification (i.e., same chemicals manufactured by two different vendors) are analyzed to verify initial calibrations. New working standard mixes (e.g., calibrations, spikes) should be verified against the results of the original solution before being put into use and be within 10% of the true value. Newly purchased standards should be verified against current data. Any impurities found in the standard must be documented. The following subsections summarize the procedures that will be used to assess data quality throughout sample analysis.

Laboratory Replicate Samples

Laboratory replicate samples provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Laboratory replicates are subsamples of the original sample that are prepared and analyzed as a separate sample, assuming sufficient sample matrix is available. A minimum of one laboratory replicate sample will be analyzed for each SDG or for every 20 samples, whichever is more frequent, for inorganic and conventional parameters.

Matrix Spikes and Matrix Spike Duplicates

The analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. Through the performance of MSD analyses, information on the precision of the method is also provided for organic analyses. For organic analyses, a minimum of one MS/MSD pair will be analyzed for each SDG, when sufficient sample volume is available. For inorganic analyses (i.e., metals), a minimum of one MS sample will be analyzed for each SDG, when sufficient sample volume is available. MS/MSD samples are not performed for dioxin/furan analyses.

Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of one method blank will be analyzed for each extraction/digestion batch or for every 20 samples, whichever is more frequent.

Standard Reference Material

SRMs are samples of similar matrix and of known analyte concentration that are processed through the entire analytical procedure and used as an indicator of method accuracy. A minimum of one SRM will be analyzed for each SDG or for every 20 samples, whichever is more frequent.

Surrogate Spikes

All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods. Surrogate recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values, with the exception of the isotope dilution corrections that are required elements of the dioxin analysis (EPA 1613).

Laboratory Control Samples

LCSs are prepared from a clean matrix similar to the project samples and are spiked with known amounts of the target compounds. The recoveries of the compounds are used as a measure of the accuracy of the test methods. LCS recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values.

Internal Standard Spikes

Internal standard spikes may be used for calibrating and quantifying organic compounds and metals by means of inductively coupled plasma-mass spectrometry (ICP-MS). If internal standards are used, all calibration, QC, and project samples will be spiked with the same concentration of the selected internal standard(s). Internal standard recoveries and retention times must be within method and/or laboratory criteria.

Interference Check Samples

In order to identify specific organochlorine pesticides that may coelute with PCB congeners, single point mid-concentration PCB standards (Aroclors 1248, 1254, and 1260) should be run regularly with single-component pesticides in the initial calibration. Additional Aroclors should be analyzed if they are detected in project samples. The resulting data will be reviewed by data validators in order to assess potential interference issues that could affect the reported pesticide results and will be summarized in the data validation section of the data report.

3.6 Instrument/Equipment Testing, Inspection, and Maintenance

Prior to each field event, measures will be taken to test, inspect, and maintain all field equipment. All equipment used, including the GPS unit and digital camera will be tested for use before leaving for the field event.

The FC will be responsible for overseeing the testing, inspection, and maintenance of all field equipment. The laboratory PM will be responsible for ensuring that laboratory equipment testing, inspection, and maintenance requirements are met. The methods used in calibrating the analytical instrumentation are described in the following section.

3.7 Instrument/Equipment Calibration and Frequency

Multipoint initial calibrations will be performed on each instrument prior to sample analysis, after each major interruption to the analytical instrument, and when more than one continuing calibration verification sample does not meet the specified criteria. The number of points used in the initial calibration is defined in each analytical method. Continuing calibration verifications will be performed daily for organic analyses, once every 10 samples for the inorganic analyses and with every sample batch for conventional parameters to ensure proper instrument performance.

In addition, if an Aroclor is detected in a sample, then the standard for that Aroclor must be analyzed in the continuing calibration within 72 hours of the original detection of the Aroclor.

Gel permeation chromatography calibration verifications will be performed at least once every 7 days, and corresponding raw data will be submitted by the laboratory with the data package. In addition, florisil performance checks will be performed for every florisil lot, and the resulting raw data will be submitted with the data package, when applicable.

Calibration of analytical equipment used for chemical analyses includes instrument blanks or continuing calibration blanks, which provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately after the continuing calibration verification at a frequency of one blank for every 10 samples analyzed for inorganic analyses and one blank for every 12 hours or 10 to 20 samples for organic analyses. If the continuing calibration does not meet the specified criteria, the analysis must stop. Analysis may resume after corrective actions have been taken to meet the method specifications. All project samples analyzed by an instrument found to be out of compliance must be reanalyzed. None of the field equipment requires calibration.

3.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The field team leaders for each sampling event will have a checklist of supplies required for each day in the field (see Section 3.2.5). The FC will gather and check these supplies daily for satisfactory conditions before each field event. Batteries used in the GPS unit and digital camera will be checked daily and recharged as necessary. Supplies and consumables for field sampling will be inspected upon delivery and accepted if the condition of the supplies is satisfactory. For example, jars will be inspected to ensure that they are the correct size and quantity and have not been damaged in shipment.

3.9 NON-DIRECT MEASUREMENTS

Available historical sediment data for the EW has been evaluated for use in the SRI/FS (Anchor and Windward 2008). The historical data that have been identified as suitable for use in the SRI/FS will be used in conjunction with subsurface data to evaluate the nature and extent of sediment contamination in the EW.

3.10 DATA MANAGEMENT

All field data will be recorded on field forms (see Appendix B), which will be checked for missing information by the FC at the end of each field day and amended as necessary. After sampling has been completed, all data from field forms will be entered into a Microsoft Excel® spreadsheet for import into the project database. A secondary QC check will be done to ensure that 100% of the data were properly transferred from the field forms to the spreadsheet. This spreadsheet will be kept on the Windward network server, which is backed up daily. Field forms will be archived in the Windward library. All photographs will be transferred to the secure network or a CD at the end of the sampling effort.

Field sampling and analytical information will be submitted to EPA's Analytical Services Tracking System (ANSETS) no later than the 15th of the month after sampling activities have occurred and the sampling compositing and analysis scheme have been approved. The project QA/QC coordinator will be responsible for the submitting the required information to ANSETS.

Analytical laboratories are expected to submit data in an electronic format as described in Section 2.6.2. The laboratory PM will contact the project QA/QC coordinator prior to data delivery to discuss specific format requirements.

A library of routines will be used to translate typical electronic output from laboratory analytical systems and to generate data analysis reports. The use of automated routines ensures that all data are consistently converted into the desired data structures and that operator time is kept to a minimum. In addition, routines and methods for quality checks will be used to ensure such translations are correctly applied.

Written documentation will be used to clarify how field and analytical laboratory duplicates and QA/QC samples were recorded in the data tables and to provide explanations of other issues that may arise. The data management task will include keeping accurate records of field and laboratory QA/QC samples so that project team members who use the data will have appropriate documentation. Data management files will be stored on a secure computer

4 Assessment and Oversight

4.1 Compliance Assessments and Response Actions

EPA or their designees may observe field activities during each sampling event, as needed. If situations arise in which there is an inability to follow QAPP methods precisely, the Windward PM will determine the appropriate actions or consult EPA if the issue is significant.

4.1.1 Compliance assessments

Laboratory and field performance assessments consist of onsite EPA reviews of sampling procedures, QA systems, adherence to the QAPP, and equipment for sampling, calibration, and measurement. EPA personnel may conduct a laboratory audit prior to sample analysis. Any pertinent laboratory audit reports will be made available to the project QA/QC coordinator upon request. Analytical laboratories are required to have written procedures to address internal QA/QC; these procedures will be submitted to the project QA/QC coordinator for review to ensure compliance with the QAPP. All laboratories and QA/QC coordinators are required to ensure that all personnel engaged in sampling and analysis tasks have appropriate training.

4.1.2 Response actions for field sampling

The FC, or a designee, will be responsible for correcting equipment malfunctions throughout field sampling and for resolving situations in the field that may result in nonconformance or noncompliance with the QAPP. All corrective measures will be immediately documented in the field logbook, and protocol modification forms will be completed.

4.1.3 Corrective action for laboratory analyses

Analytical laboratories are required to comply with their current written standard operating procedures (SOPs), laboratory QA plan, and analytical methods. Laboratory personnel will identify and correct any anomalies before continuing with sample analysis and will be responsible for reporting problems that may compromise the quality of the data. The laboratory PMs will be responsible for ensuring that appropriate corrective actions are initiated, as required, for conformance with this QAPP.

The project QA/QC coordinator will be notified immediately if any QC parameter exceeds the project DQIs outlined in this QAPP (Table 3-7) and cannot be resolved through standard corrective action procedures. A description of the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be submitted with the data package and described in the case narrative or corrective action form.

4.2 Reports to Management

The PM will update EWG and EPA regarding the status of field sampling activities following the sampling event. The project QA/QC coordinator will also update EWG and EPA after the sampling is completed and samples have been submitted for analyses, when information is received from the laboratory, and when analyses are complete. The status of the samples and analyses will be indicated with emphasis on any deviations from the QAPP. A data report will be prepared after validated data are available, as described in Section 2.6.4.

5 Data Validation and Usability

5.1 Data Validation

The laboratory analyst is responsible for ensuring that the analytical data are correct and complete, that appropriate procedures have been followed, and that QC results are within the acceptable limits. The data validation process begins at the laboratory with the review and evaluation of data by supervisory personnel or QA specialists. The project QA/QC coordinator is responsible for ensuring that all analyses performed by the laboratories are correct, properly documented, and complete, and that they satisfy the project DQOs specified in this QAPP.

Data are not considered final until validated. Data validation will be conducted following EPA guidance (1999, 2004, 2005, 2009). Independent third-party data review and summary validation of the analytical chemistry data will be conducted by EcoChem. A minimum of 20% of sample results or a single SDG will undergo full level (EPA Stage 3 for inorganic parameters or Stage 4 for organic parameters) data validation. In addition, all dioxin/furan data will undergo full validation (EPA Stage 4) following EPA national guidance for validation of dioxin/furan data (EPA 2005). Full level (EPA Stage 3 or 4) data validation parameters include:

- Quality control analysis frequencies
- Analysis holding times

- Laboratory blank contamination
- Instrument calibration
- Surrogate recoveries
- LCS recoveries
- MS recoveries
- MS/MSD RPDs
- Compound identifications (Stage 4 only)
- Compound quantitations
- Instrument performance checks (i.e., tune ion abundances)
- Internal standard areas and retention time shifts
- All pesticide chromatograms must be reviewed for PCB interference, as indicated in Section 3.5.2.2, Interference Check Samples.

If no discrepancies between reported results and raw data in the set that undergoes full (EPA Stage 3 or 4) data validation are identified, validation can proceed as a summary-level (EPA Stage 2b) data validation on the rest of the data using all the QC forms submitted in the laboratory data package. Rinsate blank samples will undergo a compliance screening level validation (EPA Stage 1 or 2a). QA review of the sediment chemistry data will be performed in accordance with the QA requirements of the project; the technical specifications of the analytical methods indentified in Table 3-6; and EPA guidance for organic and inorganic data review (EPA 1999, 2004, 2005). The EPA PM will have EPA peer review the third-party validation or if necessary, perform data assessment/validation on a percentage of the data. The EPA QA officer will receive electronic copies of the data validation report(s) and all associated raw data packages on or before the date that the draft data report is submitted to the EPA PM.

All discrepancies and requests for additional, corrected data will be discussed with the laboratories prior to issuing the formal data validation report. The project QA/QC coordinator should be informed of all contacts with the laboratories during data validation. Review procedures used and findings made during data validation will be documented on worksheets. The data validator will prepare a data validation report that will summarize QC results, qualifiers, and possible data limitations. Only validated data with appropriate qualifiers will be released for use in the EW SRI/FS. Rejected data will not be used for any purpose.

5.2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

The data quality assessment will be conducted by the project QA/QC coordinator. The results of the third-party independent review and validation will be reviewed, and cases where the project's DQOs were not met will be identified. The usability of the data depends on a variety of factors and will be determined in terms of the magnitude of the DQO exceedance. The QA/QC coordinator will consult the data user to provide a context-specific evaluation of the impact of qualified data on its use.

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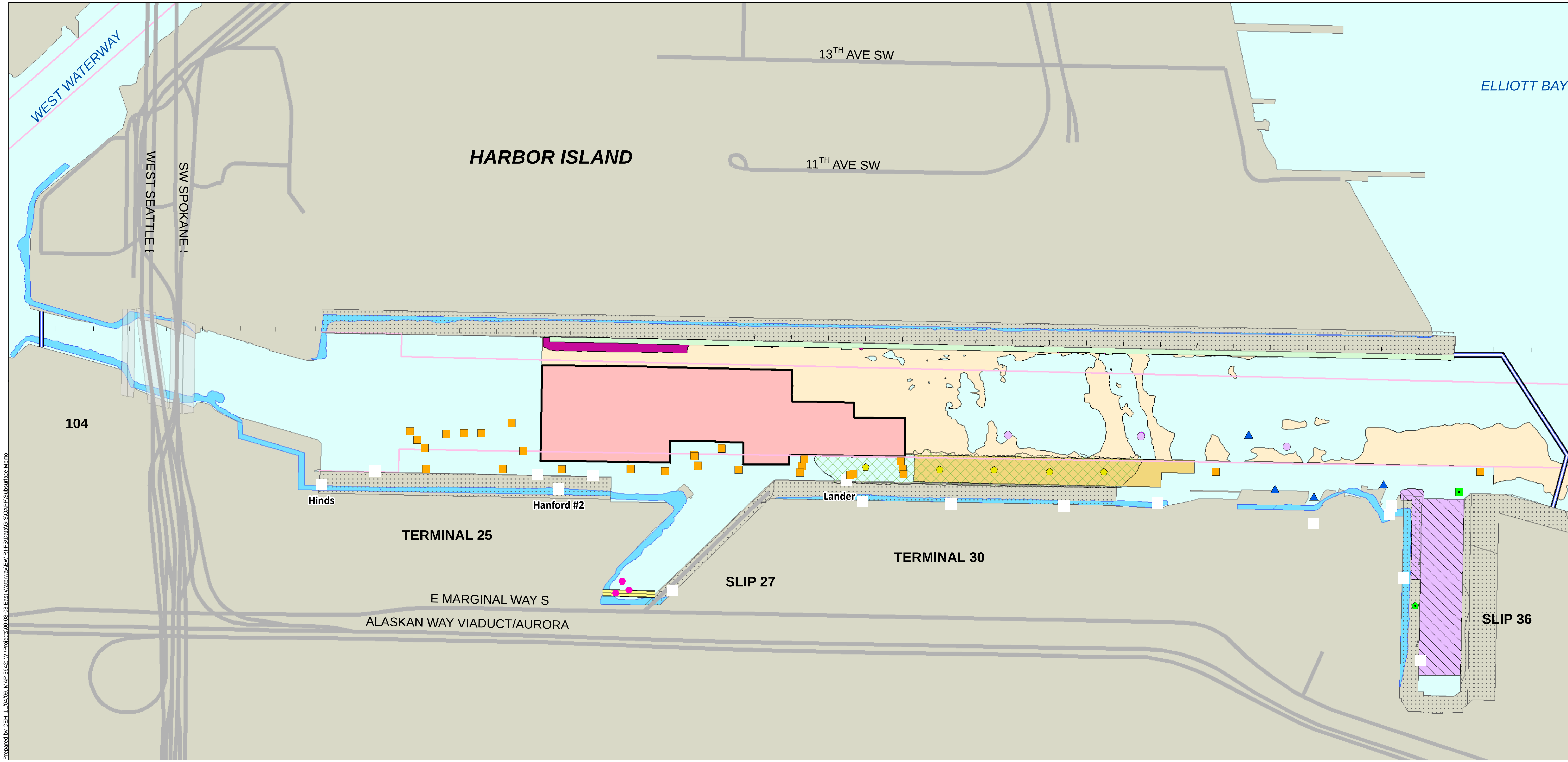
Oversize Maps

Map 1-1
Location of the EW
Subsurface Sediment QAPP
East Waterway Study Area



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Historical Subsurface Sediment Locations by Event

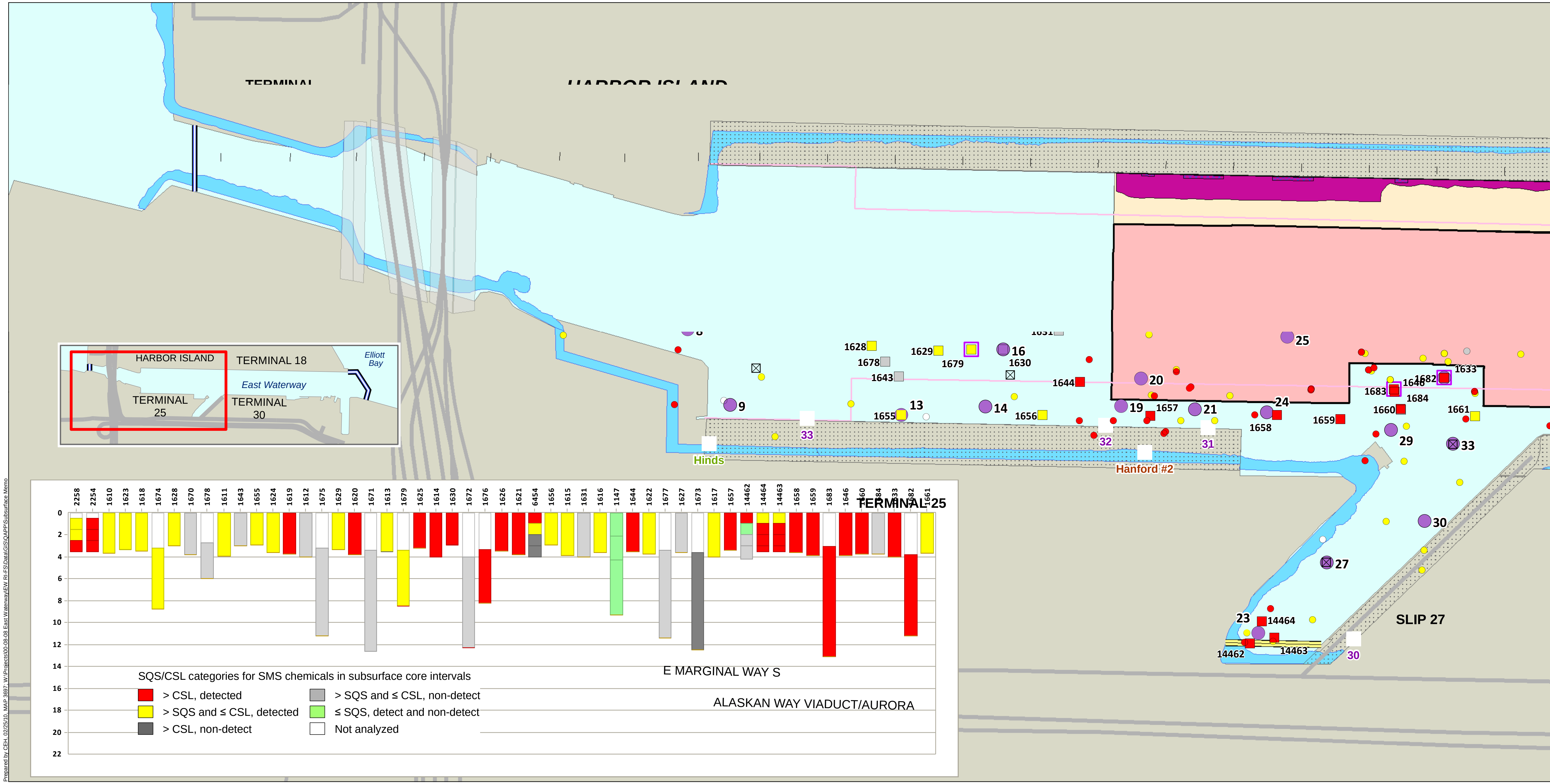
- Harbor Island RI (1991)
- Pier35 (1992)
- HIRI95 (1995)
- T18-Phase1 (1996)
- T18-Phase 2 (1996)
- Pier36-prelim (1997)
- EW-ChannelDeep (1998)
- EW/HI Nature and Extent Phase 3b (2001)
- T30 (2006)
- East Waterway - Slip 27 (2007)

- CSO
- Storm Drain
- CSO/Storm Drain
- East Waterway Study Area Boundary
- Dock/Pier
- Slip 27 Bridge
- West Seattle/Spokane St Bridge
- Road
- Navigation Channel

- T-18 (Proposed 2009)
- Stage 1a (Completed 2006, -51 MLLW)
- Phase 1 Removal Action Boundary (Completed 2005, -51 MLLW)
- Stage 1 (Completed 2000, -51 MLLW)
- Intertidal Zone

0 600
Scale in feet

Map 2-1
Historical subsurface sediment locations
Subsurface Sediment QAPP
East Waterway Study Area



SRI subsurface sampling location

SQS/CSL categories for all chemicals in subsurface sediment

- > CSL, detect
- > SQS and ≤ CSL, detect
- > CSL, non-detect
- > SQS and ≤ CSL, non-detect
- ≤ SQS, detect

Subsurface sediment core > 8 ft

Geochronological core

SQS/CSL categories for all chemicals in surface sediment

- > CSL, detect
- > SQS and ≤ CSL, detect
- > CSL, non-detect
- > SQS and ≤ CSL, non-detect
- ≤ SQS, detect

Terminal 18 maintenance dredge (completed 2009, -51 MLLW)

Stage 1a (completed 2006, -51 MLLW)

Phase 1 removal action boundary (completed 2005, -51 MLLW)

Stage 1 (completed 2000, -51 MLLW)

Intertidal zone

CSO

Storm drain

CSO/storm drain

East Waterway Study Area Boundary

Dock/Pier

Slip 27 Bridge

Road

Navigation channel

0 600

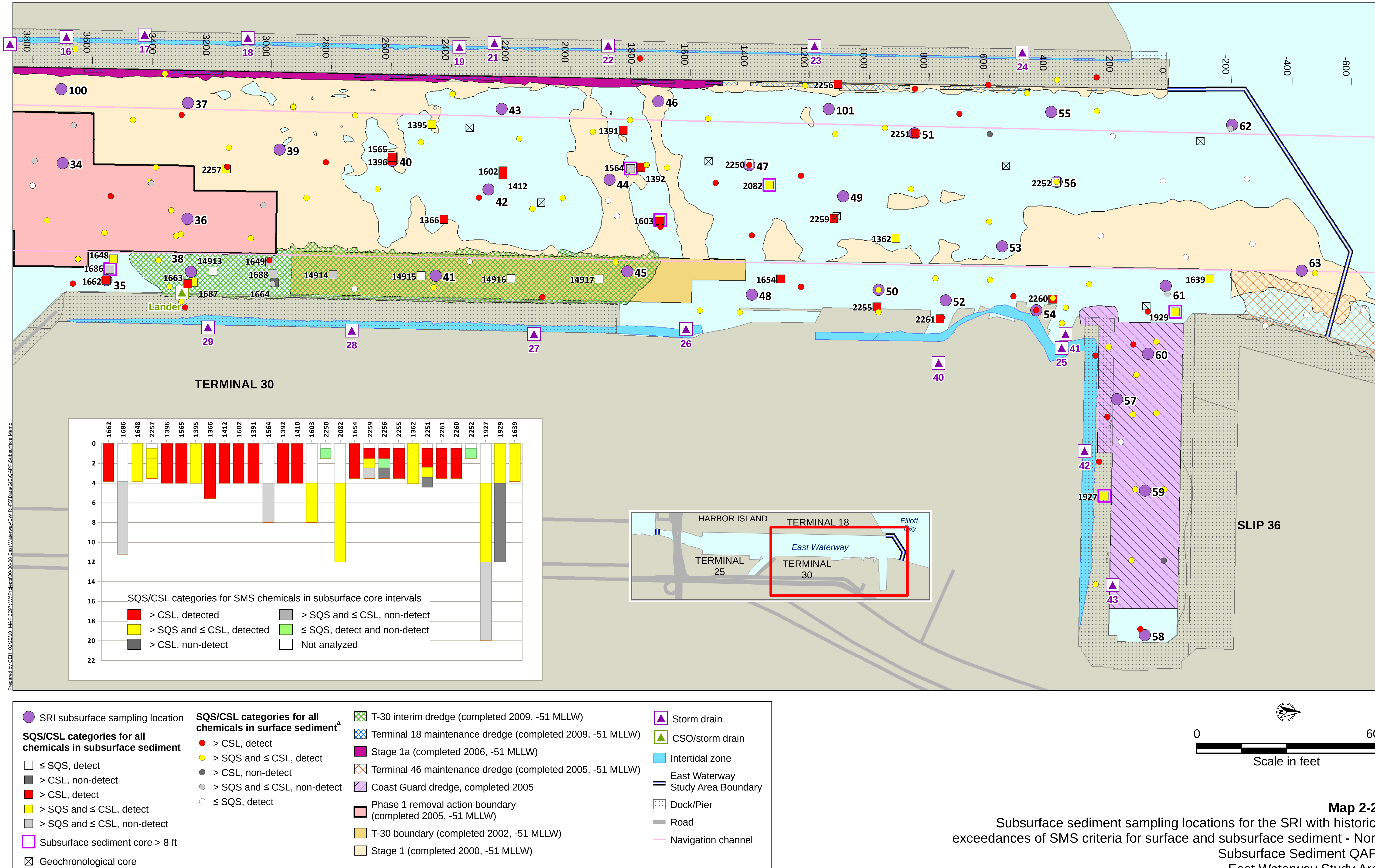
Scale in feet

Map 2-2a

Subsurface sediment sampling locations for the SRI with historical exceedances of SMS criteria for surface and subsurface sediment - South

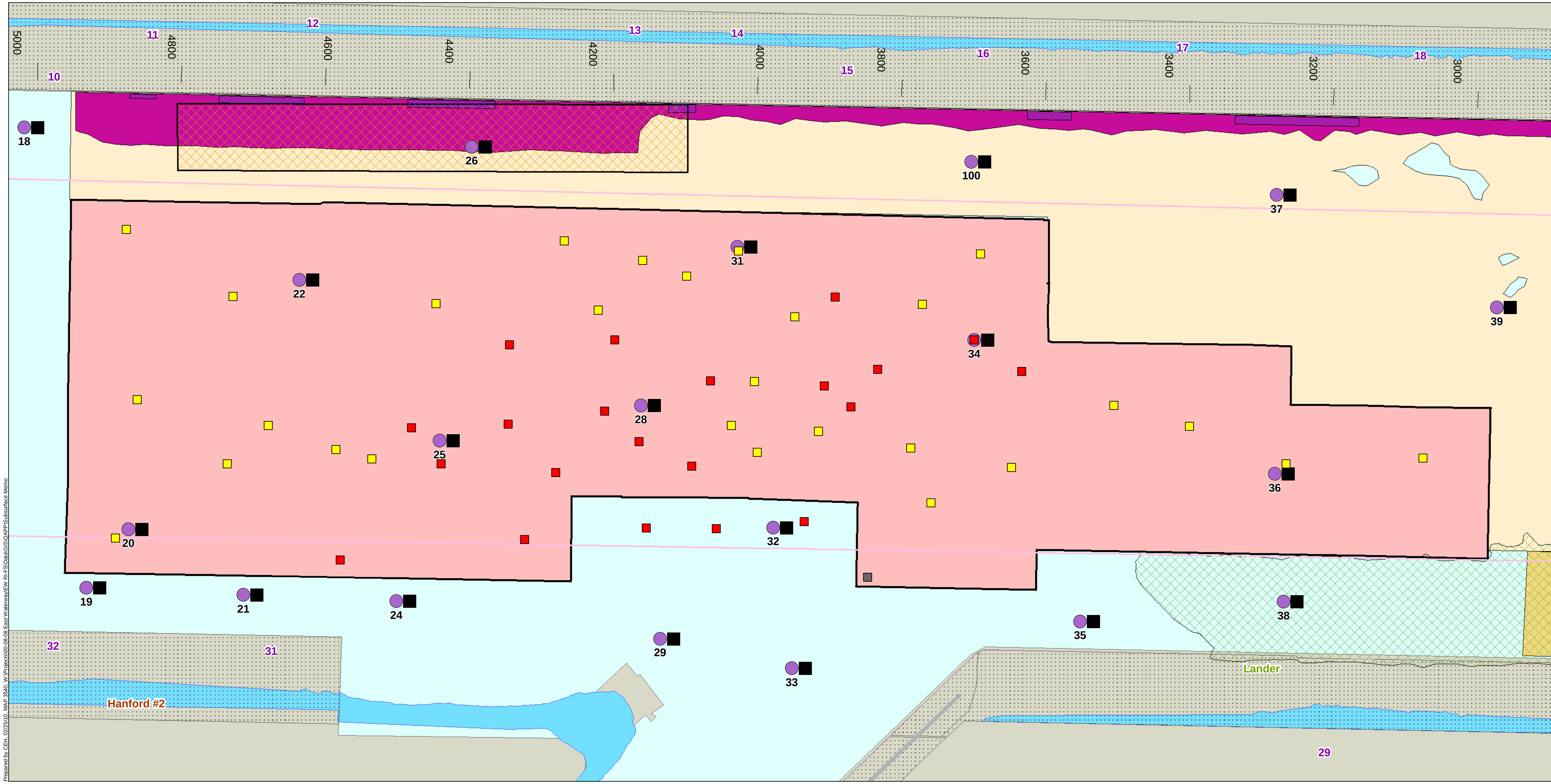
Subsurface Sediment QAPP

East Waterway Study Area



[a] Additional post-dredge samples in the T-30 dredged area were collected and archived. Results represent analytical samples only.

Map 2-2b
Subsurface sediment sampling locations for the SRI with historical exceedances of SMS criteria for surface and subsurface sediment - North
Subsurface Sediment QAPP
East Waterway Study Area



Proposed sampling location

SQS/CSL categories for all chemicals in surface sediment

- > CSL, detect
- > SQS and ≤ CSL, detect
- > CSL, non-detect

T-30 interim dredge (completed 2009, -51 MLLW)

Terminal 18 maintenance dredge (completed 2009, -51 MLLW)

Stage 1a (completed 2006, -51 MLLW)

Phase 1 removal action boundary (completed 2005, -51 MLLW)

Stage 1 (completed 2000, -51 MLLW)

T-20 approximate dredge area (completed 1982)

Intertidal zone

CSO

Storm drain

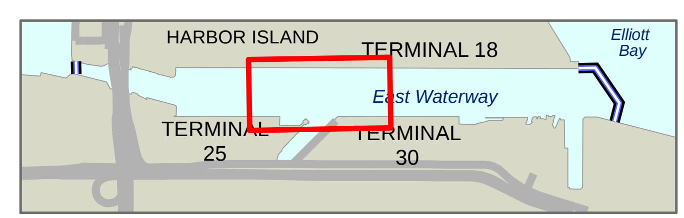
CSO/storm drain

East Waterway Study Area Boundary

Dock/Pier

Road

Navigation channel



0 300

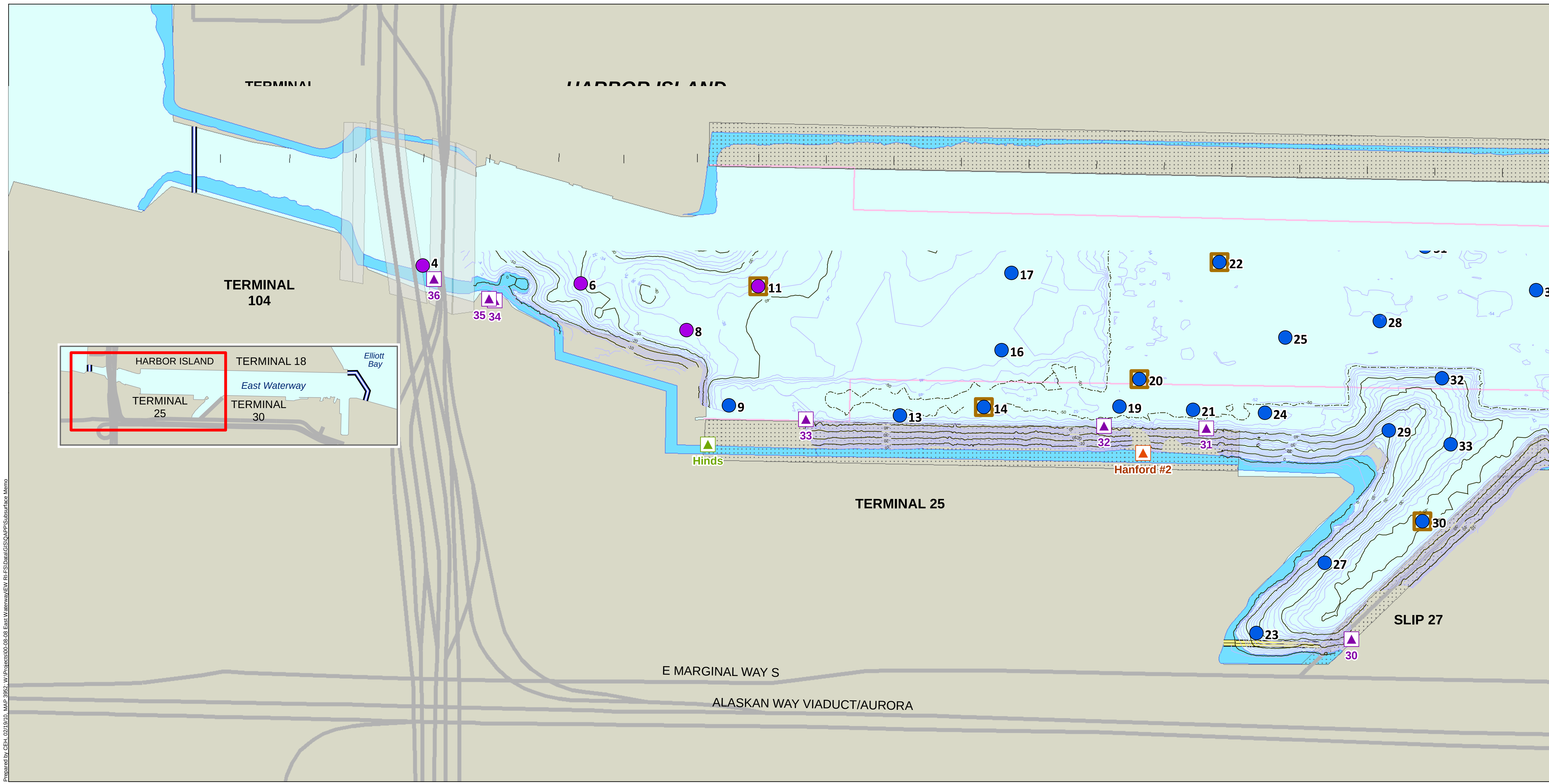
Scale in feet

Map 2-3

Historical exceedances of SMS criteria in surface sediment samples collected in the Phase 1 removal area after dredging and prior to clean sand placement

Subsurface Sediment QAPP

East Waterway Study Area

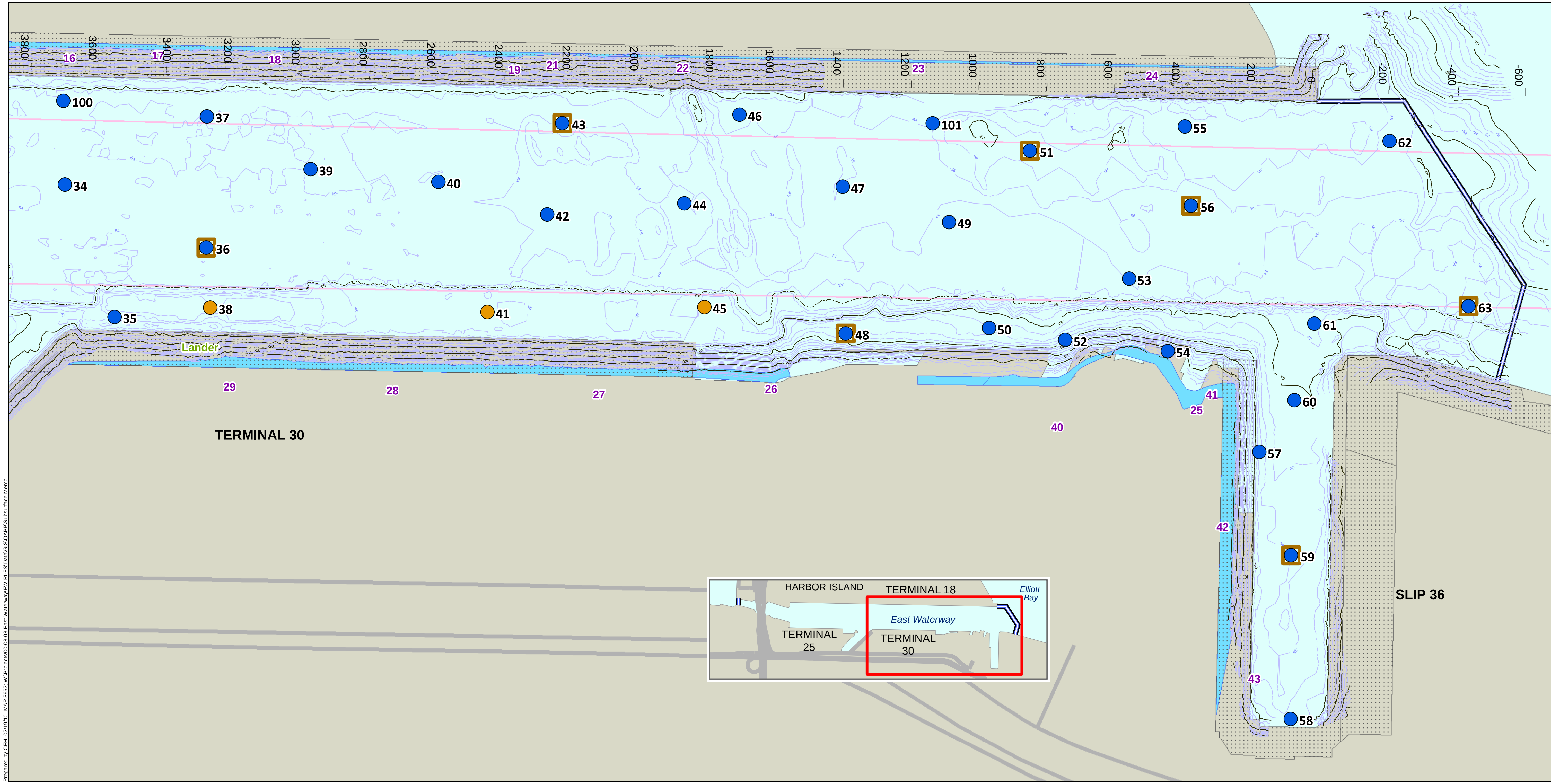


SRI subsurface sampling location

- Method A
- Method B
- Geotech core
- Intertidal zone
- CSO
- Storm drain
- CSO/storm drain
- East Waterway Study Area Boundary
- Dock/Pier
- Slip 27 Bridge
- Road
- Navigation channel

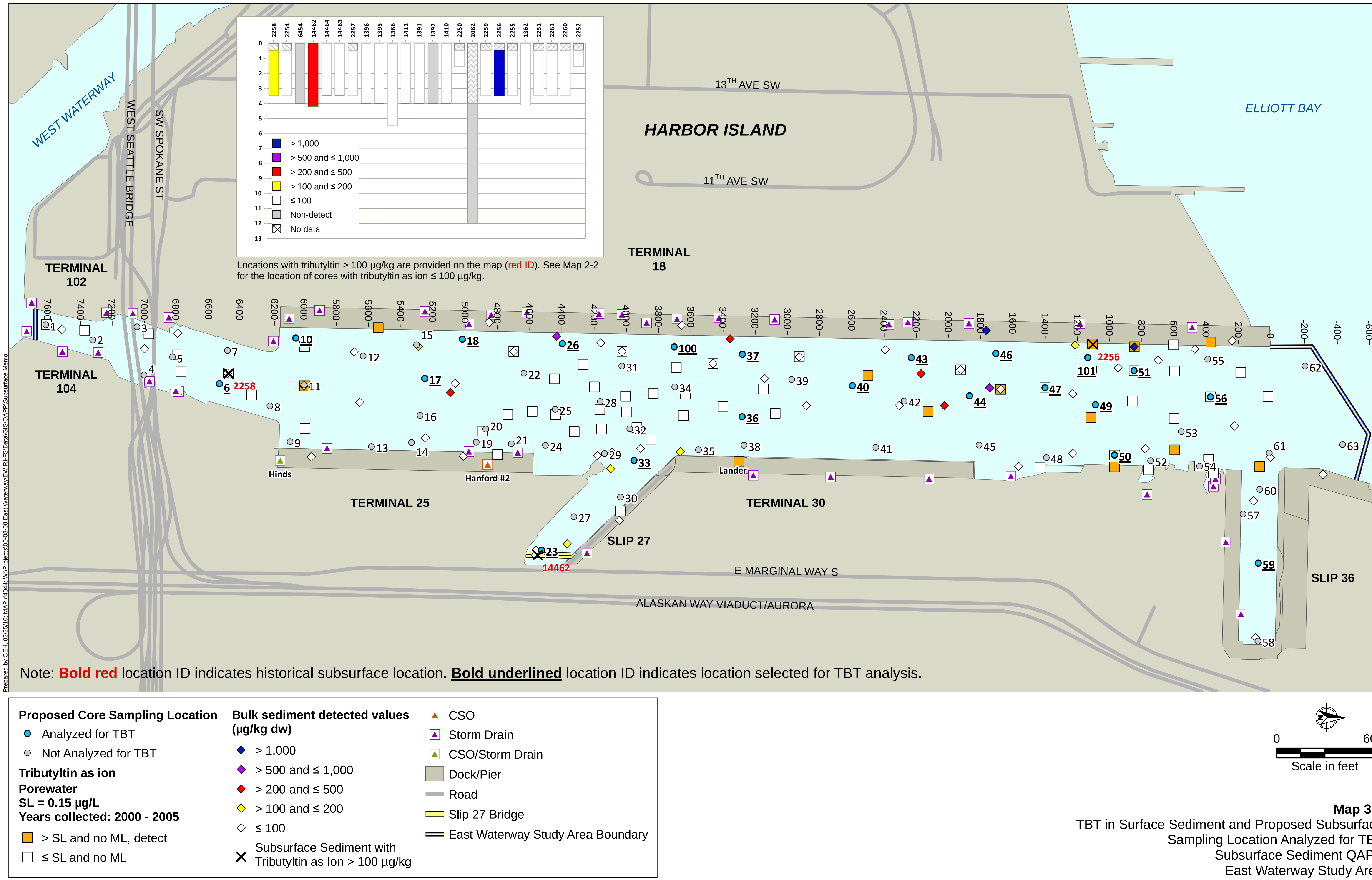
0 600
Scale in feet

Map 2-4a
Subsurface sediment sampling locations for the SRI with bathymetry - South
Subsurface Sediment QAPP
East Waterway Study Area

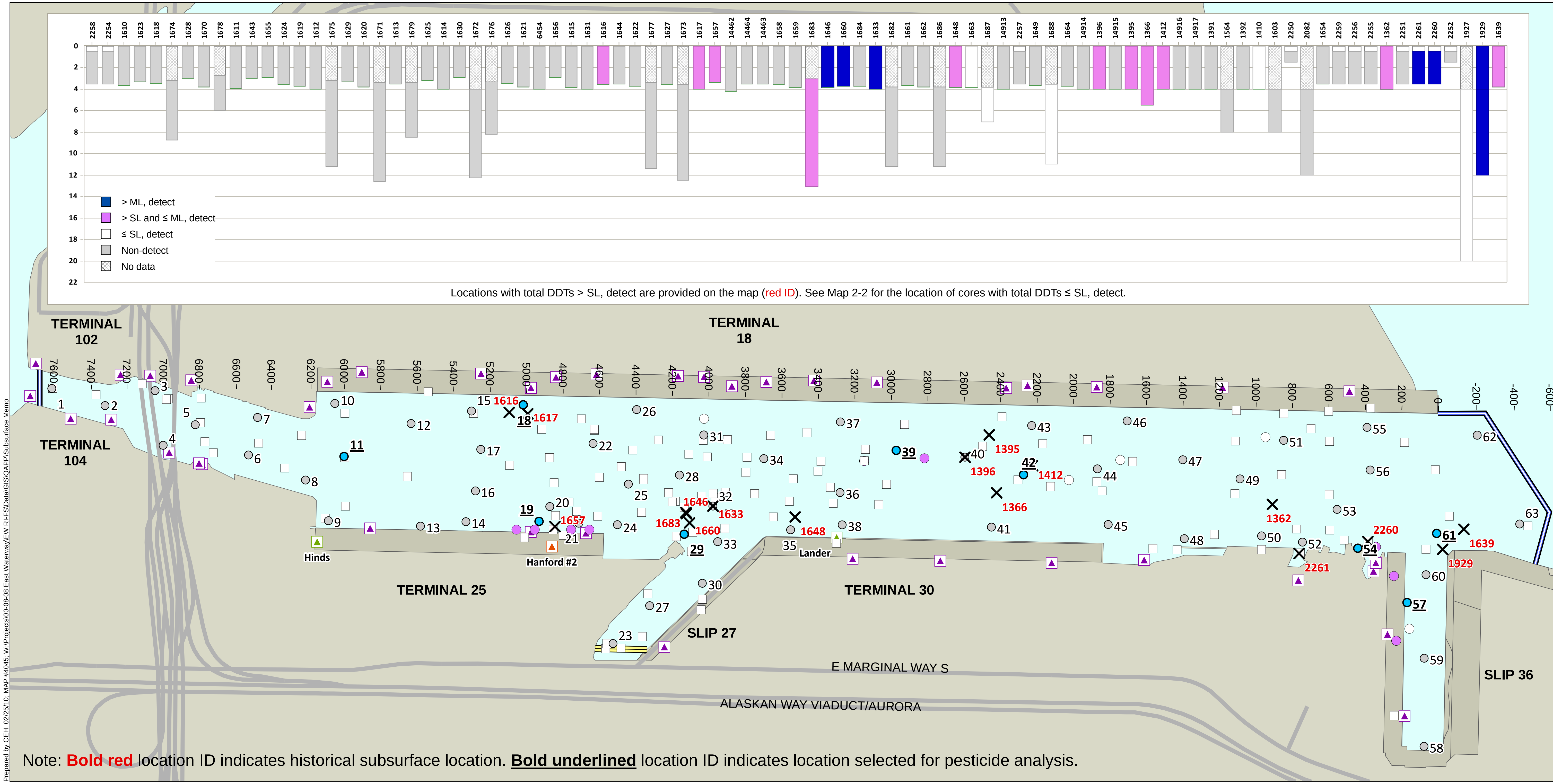


SRI subsurface sampling location
- Method A
- Method C
- Geotech core
- Intertidal zone
- Storm drain
- CSO/storm drain
- East Waterway Study Area Boundary
- Dock/Pier
- Road
- Navigation channel

Map 2-4b
Subsurface sediment sampling locations for the SRI with bathymetry - North
Subsurface Sediment QAPP
East Waterway Study Area



Map 3-1
TBT in Surface Sediment and Proposed Subsurface Sampling Location Analyzed for TBT
Subsurface Sediment QAPP
East Waterway Study Area



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Proposed Core Sampling Location
- Analyzed for Pesticides
- Not Analyzed for Pesticides

Total DDTs in Surface Sediment
- > SL and ≤ ML, detect
- ≤ SL, detect
- Non-detect
- Subsurface Sediment with Total DDTs > SL, detect

- CSO
- Storm Drain
- CSO/Storm Drain
- Dock/Pier
- Road
- Slip 27 Bridge
- East Waterway Study Area Boundary

0 600
Scale in feet

Map 3-2
Pesticides in Surface Sediment and Proposed Subsurface Sampling Location Analyzed for Pesticides
Subsurface Sediment QAPP
East Waterway Study Area

Map 3-2 Pesticides in surface sediment and proposed subsurface sampling location analyzed for pesticides analysis

APPENDIX A

Health and Safety Plan

EAST WATERWAY OPERABLE UNIT SUPPLEMENTAL REMEDIAL INVESTIGATION/ FEASIBILITY STUDY APPENDIX A: HEALTH AND SAFETY PLAN FOR SUBSURFACE SEDIMENT SAMPLING

For submittal to:

The US Environmental Protection Agency
Region 10
Seattle, WA

February 2010

Prepared by: Windward environmental LLC

200 West Mercer Street, Suite 401 • Seattle, Washington • 98119

Health and Safety Plan

By their signature, the undersigned certify that this health and safety plan is approved and that it will be used to govern health and safety aspects of fieldwork described in the quality assurance project plan to which it is attached.

Susan McGroddy Project Manager	February 19, 2010 Date
Tad Deshler Corporate Health and Safety Manager	February 19, 2010 Date
Berit Bergquist Field Coordinator/Health and Safety Officer	February 19, 2010 Date

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Acronyms

AED	automated external defibrillator
CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
EW	East Waterway
FC	field coordinator
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	health and safety manager
HSO	health and safety officer
HSP	health and safety plan
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	project emergency coordinator
PFD	personal flotation device
PPE	personal protective equipment
PM	project manager
QAPP	quality assurance project plan
ROV	remotely operated video
TCDD	tetrachlorodibenzo-*p*-dioxin
USCG	US Coast Guard

1 Introduction

This site-specific health and safety plan (HSP) describes safe working practices for conducting field activities at potentially hazardous sites and for handling potentially hazardous materials or waste products. This HSP covers elements as specified in 29CFR1910§120. The goal of the HSP is to establish procedures for safe working practices for all field personnel.

This HSP addresses all activities associated with collection and handling of subsurface sediment samples in the East Waterway (EW). During site work, this HSP will be implemented by the field coordinator (FC), who is also the designated site health and safety officer (HSO), in cooperation with the corporate health and safety manager (HSM) and the project manager (PM).

All personnel involved in fieldwork on this project are required to comply with this HSP. The content of this HSP reflects the types of activities that are anticipated to be performed, knowledge of the physical characteristics of the site, and consideration of preliminary chemical data from previous investigations at the site. The HSP may be revised based on new information and/or changed conditions during site activities. Revisions will be documented in the project records.

2 Site Description and Project Scope

2.1 SITE DESCRIPTION

The sampling area is in the EW (see Map 1-1 in the quality assurance project plan [QAPP] to which this HSP is attached). The area is affected by tidal fluctuations. The QAPP to which this HSP is attached provides complete details of the sampling program.

2.2 SCOPE AND DURATION OF WORK

Subsurface sediment cores will be collected to depths of up to 14 ft using both a vibracorer and an impact core sampler called the MudMole™. The vibracore samples will be collected from the a research vessel owned and operated by Marine Sampling Systems and the MudMole™ cores will be collected from a 30-ft pontoon boat owned and operated by AMEC Geomatrix. Scuba divers from Research Support Services, Inc. (RSS) will assist with the collection of MudMole™ cores at all locations where the water depth is greater than 5 ft. Sediment coring will be conducted from February 22 to March 12, 2010. Additional details on the sampling design and sampling methods are provided in Sections 3.1 and 3.2 of the QAPP, respectively.

3 Health and Safety Personnel

Key health and safety personnel and their responsibilities are described below. These individuals are responsible for the implementation of this HSP.

Project Manager: The PM has overall responsibility for the successful outcome of the project. The PM will ensure that adequate resources and budget are provided for the health and safety staff to carry out their responsibilities during fieldwork. The PM, in consultation with the HSM, makes final decisions concerning the implementation of the HSP.

Field Coordinator/Health and Safety Officer: Because of the limited scope and duration of fieldwork, the FC and HSO will be the same individual. The FC/HSO will direct field sampling activities, coordinate the technical components of the field program with health and safety components, and ensure that work is performed according to the QAPP. The FC/HSO will implement this HSP at the work location and will be responsible for all health and safety activities and the delegation of duties to a health and safety technician in the field, if appropriate. The FC/HSO also has stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation. The FC/HSO or her designee shall be present during sampling and operations.

Corporate Health and Safety Manager: The HSM has overall responsibility for the preparation, approval, and revision of this HSP. The HSM will not necessarily be present during fieldwork but will be readily available, if required, for consultation regarding health and safety issues during fieldwork.

Field Crew and Dive Team: All field crew and dive team members must be familiar and comply with the information in this HSP. They also have the responsibility to report any potentially unsafe or hazardous conditions to the FC/HSO immediately. The dive team members must also adhere to practices in Research Support Services' Safe Practices Manual for Diving Operations (Attachment 1).

4 Hazard Evaluation and Control Measures

This section discusses potential physical and chemical hazards that may be associated with the proposed project activities and presents control measures for addressing these hazards. The activity hazard analysis (Section 4.4) lists the potential hazards associated with each site activity and the recommended site control. Confined space entry will not be necessary for this project. Therefore, hazards associated with this activity are not discussed in this HSP.

4.1 Physical Hazards

For this project, it is anticipated that physical hazards present a greater risk of injury than do chemical hazards.

4.1.1 Slips, trips, and falls

As with all fieldwork sites, caution should be exercised to prevent slips on slick surfaces. In particular, sampling from a boat or other floating platform requires careful attention to minimize the risk of falling down or falling overboard. The same care should be used in rainy conditions or on the shoreline where there are slick rocks. Slips can be minimized through the use of boots with good treads, made of material that does not become overly slippery when wet.

Trips are always a hazard on the uneven deck of a boat, in cluttered work areas, or in the intertidal zone where uneven substrate is common. Personnel will keep work areas as free as possible from obstacles that could interfere with walking.

Falls can also be a hazard. Personnel can avoid falls by working as far from exposed edges as possible, erecting railings, and using fall protection when working on elevated platforms. For this project, no work that would present a fall hazard is anticipated.

4.1.2 Sampling equipment

Core samplers (the vibracorer or MudMole™) will be deployed from the boat to collect sediment cores. Care will be taken to ensure that the samplers are safely guided over the railing and into the water. Before sampling activities begin, there will be a training session for all field personnel for the equipment that will be onboard the sampling vessel.

4.1.3 Falling overboard

Most of the sampling activities will be done from a boat. As with any work from a floating platform, there is a chance of falling overboard. Personal flotation devices (PFDs) will be worn by all personnel while working from the boat.

4.1.4 Manual lifting

Equipment and samples must be lifted and carried. Back strain can result if lifting is done improperly. During any manual handling tasks, personnel should lift with the load supported by their legs, not their backs. For heavy loads, an adequate number of people, or if possible, a mechanical lifting/handling device, will be used.

4.1.5 Heat stress, hypothermia, or frostbite

Sampling operations and conditions that might result in the occurrence of heat stress are not anticipated. The sampling will occur during the time of year when cold weather conditions may occur, making hypothermia or frostbite a concern. The FC/HSO will monitor all crew members for early symptoms of hypothermia (e.g., shivering, muscle incoordination, mild confusion). If such symptoms are observed, the FC/HSO will take immediate steps to reduce heat loss by providing extra layers of clothing or by temporarily moving the affected crew member to a warmer environment.

4.1.6 Weather

In general, field team members will be equipped for the normal range of weather conditions. The FC/HSO will be aware of current weather conditions and of the potential for those conditions to pose a hazard to the field crew. Some conditions that might force work stoppage are electrical storms, high winds, or high waves resulting from winds.

4.1.7 Sharp objects

Sampling operations might result in the exposure of field personnel to sharp objects on top of or buried within the sediment. If these objects are encountered, field personnel should not touch them. Also, field personnel should not dig in the sediment by hand.

4.1.8 Scuba diving

Scuba diving presents an array of risks not common to a normal worksite. Therefore, tasks that involve diving will be performed by a professional diver who has been properly trained and certified and is aware of the myriad inherent risks involved with scuba diving in hazardous environments. With proper training, the risk of these potential hazards can be minimized. Commercial divers provided by Research Support Services will adhere to their Safe Practices Manual for Diving Operations (Attachment 1).

The diver will dive line-tended, with wireless communication to the surface. A safety diver will tend the line and wear a headset to talk with the diver in the water. The safety diver will also be suited up and ready to don gear if necessary. In the unlikely event that the in-water diver would require assistance, the diver could be retrieved using the tending line or assisted by the safety diver. Emergency oxygen and first aid will be on the boat, including an automated external defibrillator (AED).

Equipment failure is always a concern. Divers should be familiar with their specific type of equipment and check the tank, regulator, buoyancy control device, gauges, and any other equipment to make sure everything is in proper working order prior to use. The compressed air supply is filled by a local dive store so an air check is not necessary. The diver is also equipped with a pony bottle, which is a small emergency (bailout) air tank.

Divers must be careful to avoid pilings and other obstacles that might snag gear or entrap the diver. Having a clear sense of the layout of the area before getting into the water and taking extra caution during times of low visibility will minimize the risk from these hazards.

Hypothermia sets in much more quickly in water than in air. Wearing proper insulation and knowing the symptoms can help prevent this hazard. Warm clothes should be available on board the support boat.

Nitrogen narcosis is a risk associated with spending too much time at depth. This project will not require diving below approximately 50 ft, so the risk of narcosis is minimal. However, it is still necessary to consult dive tables to create a dive profile for each dive. Strict adherence to the diver safety manual should prevent nitrogen narcosis.

If boat traffic is a possibility, a dive flag must be deployed in the vicinity of the divers. Divers should surface as close as possible to the flag and/or support boat. Diving will not be done in the channel, where shipping activity takes place. The dive tender will continuously monitor Channels 13, 14, and 16 for boat traffic near the dive area, advise other vessels of diving operations, and, if possible, warn off boat traffic that may pose a hazard to divers.

4.2 VESSEL HAZARDS

Because of the high volumes of vessel and barge traffic on the EW, precautions and safe boating practices will be implemented to ensure that the field boat does not interrupt vessel traffic. Additional potential vessel emergency hazards and responses are listed in Table 1.

Table 1. Potential vessel emergency hazards and responses

Potential Emergency or Hazard	Response
Fire or explosion	If manageable, personnel should attempt to put out a small fire with a fire extinguisher. Otherwise, personnel should call the USCG or 911 and evacuate the area (by rescue boat or swimming) and meet at a designated area. The FC/HSO will take roll call to make sure everyone evacuated safely. Emergency meeting places will be determined in the field during the daily safety briefing.
Medical emergency or injury	At least one person with current first aid and CPR training will be aboard the vessel at all times. This person will attempt to assess the nature and severity of the injury, immediately call 911, and perform CPR if necessary. Personnel should stop work and wait for medical personnel to arrive. Once the emergency has passed, the FC/HSO should fill out a site accident report.
Person overboard	All personnel aboard the sampling vessel will wear PFDs at all times. One person should keep an eye on the individual who fell overboard and shout the distance (boat lengths) and direction (o'clock) of the individual from the vessel. Personnel should stop work and use the vessel to retrieve the individual in the water.
Sinking vessel	Personnel should call the USCG immediately. If possible, personnel should wait for a rescue boat to arrive to evacuate vessel personnel. See fire or explosion (above) for emergency evacuation procedures. The FC/HSO will take a roll call to make sure everyone is present.
Lack of visibility	If navigation visibility or personal safety is compromised because of smoke, fog, or other unanticipated hazards, personnel should stop work immediately. The vessel operator and FC/HSO will assess the hazard and, if necessary, send out periodic horn blasts to mark vessel location to other vessels potentially in the area, move to a secure location (i.e., berth), and wait for the visibility to clear.
Loss of power	Personnel should stop work and call the USCG for assistance. Personnel should use oars to move the vessel towards the shoreline. Other vessel personnel should watch for potential collision hazards and notify the vessel operator if hazards exist. Personnel should secure the vessel to a berth, dock, or mooring as soon as possible.

Potential Emergency or Hazard	Response
Collision	Personnel should stop work and call the USCG for assistance. The FC/HSO and vessel operator will assess damage and potential hazards. If necessary, the vessel will be evacuated and secured until repairs can be made.

CPR – cardiopulmonary resuscitation
FC – field coordinator
HSO – health and safety officer
PFD – personal flotation device
USCG – US Coast Guard

4.3 Chemical Hazards

Previous investigations have shown that some chemical substances are present at higher-than-background concentrations in the sampling area. For the purpose of discussing potential exposure to substances in sediments, the chemicals of concern are metals, tributyltin, dioxins and furans, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

4.3.1 Exposure routes

Potential routes of chemical exposure include inhalation, dermal contact, and ingestion. Exposure will be minimized by using safe work practices and by wearing the appropriate personal protective equipment (PPE). Further discussion of PPE requirements is presented in Section 7.

Inhalation — Inhalation is not expected to be an important route of exposure for this project.

Dermal exposure — Dermal exposure to hazardous substances associated with sediments, surface water, or equipment decontamination will be controlled through the use of PPE and adherence to detailed sampling and decontamination procedures.

Ingestion — Ingestion is not considered a major route of exposure for this project. Accidental ingestion of surface water is possible. However, careful handling of equipment and containers aboard the boat should prevent the occurrence of water splashing or spilling during sample collection and handling activities.

4.3.2 Chemical hazards

Metals and tributyltin — Exposure to metals may occur via ingestion or skin contact. As mentioned above, neither is likely as an exposure route. Metal fumes or metal-contaminated dust will not be encountered during field and sample handling activities. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for the passage of any of the metals into the body. Field procedures require the immediate washing of sediments from exposed skin.

Polycyclic aromatic hydrocarbons — Exposure to PAHs may occur via ingestion or skin contact. The most important human health exposure pathway for this group of chemicals, inhalation, is not expected to occur at this site. Animal studies have shown that PAHs can cause harmful effects on skin, body fluids, and ability to fight disease after both short- and long-term exposure, but these effects have not been documented in people. Some PAHs may reasonably be expected to be carcinogens. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for the passage of any of the compounds into the body. Field procedures require the immediate washing of sediments from exposed skin.

Polychlorinated biphenyls — Prolonged skin contact with PCBs may cause acne-like symptoms known as chloracne. Irritation to eyes, nose, and throat may also occur. Acute and chronic exposure can damage the liver and cause symptoms of edema, jaundice, anorexia, nausea, abdominal pains, and fatigue. PCBs are a suspected human carcinogen. Skin absorption may substantially contribute to the uptake of PCBs. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for the passage of any of these compounds into the body. Field procedures require the immediate washing of sediments from exposed skin.

Dioxins/furans — Prolonged skin contact with dioxins/furans may cause acne-like symptoms known as chloracne. Other effects to the skin, such as red skin rashes, have been reported to occur in people following exposure to high concentrations of 2,3,7,8- tetrachlorodibenzo-*p*-dioxin (TCDD). Acute and chronic exposure can damage the liver, result in an increase in the risk of diabetes and abnormal glucose tolerance, and may increase the risk for reproductive and developmental effects. 2,3,7,8-TCDD is a possible human carcinogen, and a mixture of dioxins/furans with six chlorine atoms (four of the six chlorine atoms at the 2, 3, 7, and 8 positions) is a probable human carcinogen. Skin absorption may substantially contribute to the uptake of dioxins/furans. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for the passage of any of the compounds into the body. Field procedures require the immediate washing of sediments from exposed skin.

4.4 ACTIVITY HAZARD ANALYSIS

The activity hazard analysis summarizes the field activities to be performed during the project, outlines the hazards associated with each activity, and presents controls that can reduce or eliminate the risk of the hazard occurring. Table 2 presents the activity hazard analysis for sampling from a boat and scuba diving.

Table 2. Activity hazard analysis

Activity	Hazard	Control
Sampling from a boat	falling overboard	Use care in boarding and departing from vessel. Wear a PFD.
	skin contact with contaminated sediments or liquids	Wear modified Level D PPE.
	back strain	Use appropriate lifting techniques when transporting equipment and supplies to or from the boat or seek help.
Scuba diving	loss of communication	Terminate the dive.
	equipment failure	Conduct a pre-dive check; have dive tender and/or safety diver present during dive.
	scrapes and bruises; entrapment by pilings and other obstacles	Be familiar with the area before entering the water. Exercise caution when visibility is low.
	hypothermia	Wear appropriate insulation. Be aware of the symptoms and have warm clothes available.
	nitrogen narcosis	Consult dive tables prior to each dive.
	boat traffic	Deploy the dive flag in the vicinity of the divers. Ascend carefully and as close as possible to the support boat. Have dive tender continuously monitor Channels 13, 14, and 16 for boat traffic near dive area. Ensure that dive tender advises other vessels of diving operations and warns off boat traffic that may pose a hazard to the divers.

PFD – personal flotation device
PPE – personal protective equipment

5 Work Zones and Shipboard Access Control

During sampling and sample handling activities, work zones will be established to identify where sample collection and processing are actively occurring. The intent of the zone is to limit the migration of sample material out of the zone and to restrict access to active work areas by defining work zone boundaries.

5.1 Work Zone

The work zone on the boat will encompass the area where sample collection and handling activities are performed. The work zone in the core processing area will include the immediate area surrounding the core samples and the jar labeling area. Only persons with appropriate training, PPE, and authorization from the FC/HSO will be allowed to enter the work zone while work is in progress.

5.2 Decontamination Station

A decontamination station will be set up, and personnel will clean soiled boots or PPE prior to leaving the work zone. The station will have the buckets, brushes, soapy water, rinse water, or wipes necessary to clean boots, PPE, or other equipment leaving the work zones. Plastic bags will be provided for expendable and disposable materials. If the location does not allow for the establishment of a decontamination station, the FC/HSO will provide alternatives to prevent the spread of contamination.

Decontamination of the boat will also be completed at the end of each work day. Cockpit and crew areas will be rinsed down with site water to minimize the accumulation of sediment.

5.3 ACCESS CONTROL

Boat security and access control will be the responsibility of the FC/HSO and boat captain. Boat access will be granted only to essential project personnel and authorized visitors. Any security or access control problems will be reported to the PM or appropriate authorities.

6 Safe Work Practices

Following common sense rules will minimize the risk of exposure or accident at the work site. The general safety rules listed below will be followed onsite:

- Do not climb over or under obstacles of questionable stability.
- Do not eat, drink, smoke, or perform other hand-to-mouth transfers in the work zone.
- Work only in well-lighted spaces.
- Never enter a confined space without the proper training, permits, and equipment.
- Make eye contact with equipment operators when moving within the range of their equipment.
- Be aware of the movements of shipboard equipment when not in the operator's range of vision.
- Get immediate first aid for all cuts, scratches, abrasions, or other minor injuries.
- Use the established sampling and decontamination procedures.
- Always use the buddy system.
- Be alert to your own and other workers' physical condition.
- Report all accidents, no matter how minor, to the FC/HSO.
- Do not do anything dangerous or unwise even if ordered by a supervisor.

7 Personal Protective Equipment and Safety Equipment

Appropriate PPE will be worn as protection against potential hazards. In addition, a PFD will be required for all personnel when working aboard the boat. Prior to donning PPE, personnel will inspect their PPE for any defects that might render the equipment ineffective.

Fieldwork will be conducted in Level D or modified Level D PPE, as discussed in Sections 7.1 and 7.2. Situations that would require PPE beyond modified Level D are not anticipated. Should the FC/HSO determine that PPE beyond modified Level D is necessary, the HSM will be notified and alternative PPE selected.

7.1 Level D Personal Protective Equipment

Individuals performing general activities in which skin contact with contaminated materials is unlikely will wear Level D PPE. Level D PPE includes the following:

- Cotton overalls or lab coats
- Chemical-resistant steel-toed boots
- Chemical-resistant gloves
- Safety glasses

7.2 Modified Level D Personal Protective Equipment

Individuals performing activities in which skin contact with contaminated materials is possible but inhalation risks are not expected will be required to wear an impermeable outer suit. The type of outerwear will be chosen according to the types of chemical contaminants that might be encountered. Modified Level D PPE includes the following:

- Impermeable outer garb, such as rain gear or waders
- Chemical-resistant steel-toed boots
- Chemical-resistant outer gloves

7.3 Safety Equipment

In addition to the above-identified PPE, basic emergency and first aid equipment will also be provided. Equipment for the field team will include:

- A copy of this HSP
- First aid kit adequate for the number of personnel in the field crew
- Emergency eyewash

The FC/HSO will ensure that the safety equipment is available. Equipment will be checked daily to ensure its readiness for use.

8 Monitoring Procedures for Site Activities

A monitoring program that addresses the potential site hazards will be implemented. For this project, air, dust, and noise monitoring will not be necessary. The sampled media will be wet and will not pose a dust hazard, and the only equipment emitting high-amplitude (>85 dBA) sound (i.e., circular saw) will be used with the appropriate level of hearing protection. Air monitoring is not anticipated to be necessary, but a photoionization detector (PID) will be available if core processing personnel determine that noticeable levels of hydrogen sulfide are present in the sediment. In the event that the PID is used, the FC/HSO will review the readings and may establish additional engineering controls (e.g., fans or ventilation) or PPE (e.g., respirator) if the occupational exposure limits are exceeded.

For this project, the monitoring program will include all individuals monitoring themselves and their co-workers for signs of potential physical stress or illness. All personnel will be instructed to look for and inform each other of any deleterious changes in their physical or mental conditions during the performance of all field activities. Examples of such changes are as follows:

- Headaches
- Dizziness
- Nausea
- Symptoms of heat stress
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern
- Shivering
- Blue lips or fingernails

If any of these conditions develop, work will be halted immediately and the affected person(s) evaluated. If further assistance is needed, personnel at the local hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious. If the condition is the direct result of sample collection or handling activities, procedures will be modified to address the problem.

9 Decontamination

Decontamination is necessary to prevent the migration of contaminants from the work zone(s) into the surrounding environment and to minimize the risk of exposure of personnel to contaminated materials that might adhere to PPE. The following subsections discuss personnel and equipment decontamination. The following supplies will be available to perform decontamination activities:

- Wash buckets
- Rinse buckets
- Long-handled scrub brushes
- Clean water sprayers
- Paper towels
- Plastic garbage bags
- Alconox® or similar decontamination solution

9.1 Minimization of Contamination

The first step in addressing contamination is to prevent or minimize exposure to existing contaminated materials and the spread of those materials. During field activities, the FC/HSO will enforce the following measures:

Personnel

- Do not walk through areas of obvious or known contamination.
- Do not handle, touch, or smell contaminated materials directly.
- Make sure PPE has no cuts or tears prior to use.
- Fasten all closures on outer clothing, covering with tape if necessary.
- Protect and cover any skin injuries.
- Stay upwind of airborne dusts and vapors.
- Do not eat, drink, chew tobacco, or smoke in the work zones.

Sampling equipment and boat

- Place clean equipment on a plastic sheet or aluminum foil to avoid direct contact with contaminated media.
- Keep contaminated equipment and tools separate from clean equipment and tools.
- Clean boots before entering the boat.

9.2 PERSONNEL DECONTAMINATION

The FC/HSO will ensure that all site personnel are familiar with personnel decontamination procedures. Personnel will perform decontamination procedures, as appropriate, before eating lunch, taking a break, or leaving the work location. Decontamination procedures for field personnel include:

1. Rinse off the outer suit if it is heavily soiled.
2. Wash and rinse outer gloves and boots with water.
3. Remove and inspect outer gloves and discard them if damaged.
4. Wash hands if taking a break.
5. Don necessary PPE before returning to work.
6. Dispose of soiled, disposable PPE before leaving for the day.

In addition to the decontamination procedures listed above, divers will:

1. Thoroughly rinse dive suit and gear after each dive.
2. Inspect gear for mud or stains and re-rinse or scrub with Alconox®, if necessary.
3. Discard any damaged or heavily soiled gear after the project, if necessary.
4. Launder dry suit underwear after the project.

9.3 SAMPLING EQUIPMENT DECONTAMINATION

Before use at each sampling location, shovels and trowels will be rinsed in site water to dislodge and remove any sediment and ensure that they are cleared of all debris before use. Stainless steel spoons and bowls will be decontaminated before each sample is collected.

9.4 VESSEL DECONTAMINATION

Most sampling will be conducted from a boat. Care will be taken to minimize the amount of sediment spilled on the vessel. The vessel deck will be hosed off regularly to remove sediment from the cockpit and crew areas to minimize slipping hazards and the transport of sediment on boots through work zones.

10 Disposal of Contaminated Materials

Contaminated materials that may be generated during field activities include PPE, decontamination fluids, and excess sample material. These contaminated materials will be disposed of as an integral part of the project.

10.1 Personal Protective Equipment

Gross surface contamination will be removed from PPE. All disposable sampling materials and PPE, such as disposable coveralls, gloves, and paper towels used in the sample processing, will be placed in heavyweight garbage bags. Filled garbage bags will be placed in a normal refuse container for disposal as solid waste.

10.2 Excess Sample Materials

At each sampling location, excess sediment collected will be returned to the water unless a heavy odor or sheen is observed in the sediment, in which case, sediment will be contained for disposal in 55-gallon drums in the field processing laboratory. All excess sediment from cores after laboratory processing will be disposed of in 55-gallon drums for proper off-site disposal.

11 Training Requirements

Individuals who perform work at locations where potentially hazardous materials and conditions may be encountered must meet specific training requirements. It is not anticipated that hazardous concentrations of contaminants will be encountered in sampled material, so training will consist of site-specific instruction for all personnel and the oversight of inexperienced personnel by an experienced person for one working day. The following subsections describe the training requirements for this fieldwork.

11.1 Project-Specific Training

In addition to Hazardous Waste Operations and Emergency Response (HAZWOPER) training, as described in Section 2.5 of the QAPP, field personnel will undergo training specifically for this project. All personnel must read this HSP and be familiar with its contents before beginning work. Personnel will acknowledge reading the HSP by signing the Field Team Health and Safety Plan Review Form (Attachment 2). The completed form will be kept in the project files.

The boat captain and FC/HSO or a designee will provide project-specific training prior to the first day of fieldwork and whenever new workers arrive. Field personnel will not be allowed to begin work until project-specific training has been completed and documented by the FC/HSO. Training will address the HSP and all health and safety issues and procedures pertinent to field operations. Training will include, but not be limited to, the following topics:

- Activities with the potential for chemical exposure
- Activities that pose physical hazards, and actions to control the hazard
- Ship access control and procedure
- Use and limitations of PPE

- Decontamination procedures
- Emergency procedures
- Use and hazards of sampling equipment
- Location of emergency equipment
- Vessel safety practices
- Emergency evacuation and emergency procedures

11.2 Daily Safety Briefings

The FC/HSO or a designee and the boat captain will present safety briefings before the start of each day's activities. These safety briefings will outline the activities expected for the day, update work practices and hazards, address any specific concerns associated with the work location, and review emergency procedures and routes. The FC/HSO or designee will document safety briefings in the logbook.

11.3 First Aid and CPR

At least one member of the field team must have first-aid and cardiopulmonary resuscitation (CPR) training. The diver and dive tender will also be trained in first-aid and CPR as required by the Research Support Services' Safe Practices Manual for Diving Operations (Attachment 1). The first aid and CPR training should include Automated External Defibrillator (AED) training. Documentation of which individuals possess first-aid and CPR training will be kept in the project health and safety files.

12 Medical Surveillance

A medical surveillance program conforming to the provisions of 29CFR1910§120(f) will not be necessary for field team members because the field team members do not meet any of the four criteria outlined in the regulations for the implementation of a medical surveillance program:

- Employees who are or may be exposed to hazardous substances or health hazards at or above permissible exposure levels for 30 days or more per year (1910.120(f)(2)(I)
- Employees who must wear a respirator for 30 days or more per year (1910.120(f)(2)(ii))
- Employees who are injured or become ill due to possible overexposures involving hazardous substances or health hazards from an emergency response or hazardous waste operation (1910.120(f)(2)(iii))
- Employees who are members of HAZMAT teams (1910.120(f)(2)(iv))

As described in Section 8, employees will monitor themselves and each other for any deleterious changes in their physical or mental condition during the performance of all field activities.

13 Reporting and Record Keeping

Each member of the field crew will sign the HSP review form (see Attachment 2). If necessary, accident/incident report forms and Occupational Safety and Health Administration (OSHA) Form 200s will be completed by the FC/HSO.

The FC/HSO or a designee will maintain a health and safety field logbook that records health-and-safety-related details of the project. Alternatively, entries may be made in the field logbook, in which case a separate health and safety field logbook will not be required. The logbook must be bound and the pages must be numbered consecutively. Entries will be made with indelible blue ink. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all personnel
- Weather conditions
- Type of fieldwork being performed

The individual maintaining the entries will initial and date the top or bottom of each completed page. Blank space at the bottom of an incompletely filled page will be lined out. Each day's entries will begin on the first blank page after the previous workday's entries.

14 Emergency Response Plan

As a result of the hazards and the conditions under which operations will be conducted, the potential exists for an emergency situation to occur. Emergencies may include personal injury, exposure to hazardous substances, fire, explosion, or release of toxic or non-toxic substances (i.e., spills). OSHA regulations require that an emergency response plan be available to guide actions in emergency situations.

Onshore organizations will be relied upon to provide response in emergency situations. The local fire department and ambulance service can provide timely response. Field personnel will be responsible for identifying emergency situations, providing first aid, if applicable, notifying the appropriate personnel or agency, and evacuating any hazardous area. Shipboard personnel will attempt to control only very minor hazards that could present an emergency situation, such as a small fire, and will otherwise rely on outside emergency response resources.

The following subsections identify the individual(s) who should be notified in case of emergency, provide a list of emergency telephone numbers, offer guidance for particular types of emergencies, and provide directions for getting from any sampling location to a hospital.

14.1 PRE-EMERGENCY PREPARATION

Before the start of field activities, the FC/HSO will ensure that preparation has been made in anticipation of emergencies. This preparation includes the following:

- Meeting with equipment handlers concerning emergency procedures to be followed in the event of an injury
- Conducting a training session informing all field personnel of emergency procedures, locations of emergency equipment and their use, and proper evacuation procedures
- Conducting a training session (led by senior staff responsible for operating field equipment) to apprise field personnel of operating procedures and specific risks associated with field equipment
- Ensuring that field personnel are aware of the existence of the emergency response plan in the HSP and ensuring that a copy of the HSP accompanies the field team

14.2 PROJECT EMERGENCY COORDINATOR

The FC/HSO will serve as the project emergency coordinator (PEC) in the event of an emergency. She will designate a replacement for times when she is not available or is not serving as the PEC. The designation will be noted in the logbook. The PEC will be notified immediately when an emergency is recognized. The PEC will be responsible for evaluating the emergency situation, notifying the appropriate emergency response units, coordinating access with those units, and directing onboard interim actions before the arrival of emergency response units. The PEC will notify the HSM and the PM as soon as possible after initiating an emergency response action. The PM will have responsibility for notifying the client.

14.3 EMERGENCY RESPONSE CONTACTS

All personnel must know whom to notify in the event of an emergency situation, even though the FC/HSO has primary responsibility for notification. Table 3 lists the names and phone numbers for emergency response services and individuals.

Table 3. Emergency response contacts

Contact	Telephone Number
Emergency Numbers	
Ambulance	911
Police	911
Fire	911
Harborview Medical Center	(206) 323-3074
Center for Hyperbaric Medicine, Virginia Mason Medical Center	(206) 583-6543
US Coast Guard	
Office	(206) 286-5400
Emergency	(206) 442-5295
General information	UHF Channel 16
National Response Center	(800) 424-8802
US Environmental Protection Agency	(908) 321-6660
Washington State Department of Ecology – Northwest Region Spill Response (24-hour emergency line)	(206) 649-7000
Project Management Emergency Contacts	
Susan McGroddy, Project Manager	(206) 812-5421
Tad Deshler, Corporate Health and Safety Manager	(206) 812-5406
Berit Bergquist, Field Coordinator/ Health and Safety Officer	(206) 293-2632(cellular telephone)

14.4 Recognition of Emergency Situations

Emergency situations will generally be recognizable through observation. An injury or illness will be considered an emergency if it requires treatment by a medical professional and cannot be treated with simple first-aid techniques.

14.5 Decontamination

In the case of evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. If an injured individual is also heavily contaminated and must be transported by emergency vehicle, the emergency response team will be informed of the type of contamination. To the extent possible, contaminated PPE will be removed but only if doing so does not exacerbate the injury. Plastic sheeting will be used to reduce the potential for spreading contamination to the inside of the emergency vehicle.

14.6 Fire

Field personnel will attempt to control only small fires. If an explosion appears likely, personnel will follow evacuation procedures specified during the training session. If a fire cannot be controlled with the onboard fire extinguisher that is part of the required safety equipment, personnel will either withdraw from the vicinity of the fire or evacuate the site as specified during the training session.

14.7 Personal Injury

In the event of serious personal injury, including unconsciousness, possibility of broken bones, severe bleeding or blood loss, burns, shock, or trauma, the first responder will immediately do the following:

- Administer first aid, if qualified.
- If not qualified, seek out an individual who is qualified to administer first aid, if time and conditions permit.
- Notify the PEC of the incident, the name of the individual, the location, and the nature of the injury.

The PEC will immediately do the following:

- Notify the boat captain and FC/HSO, and the appropriate emergency response organization.
- Assist the injured individual.
- Follow the emergency procedures for retrieving or disposing of equipment and leave the site and proceed to the predetermined land-based emergency pick-up.
- Designate someone to accompany the injured individual to the hospital.
- If a life-threatening emergency occurs (i.e., injury in which death is imminent without immediate treatment), the FC/HSO or boat captain will call 911 and arrange to meet the emergency responder at the nearest accessible location or dock. For injuries or emergencies that are not life-threatening (e.g., broken bones, minor lacerations), the PEC will follow the procedures outlined above and proceed to the Harbor Island Marina or to an alternative location if that would be more expedient.
- Notify the HSM and the PM.

If the PEC determines that emergency response is not necessary, he or she may direct someone to decontaminate and transport the individual by vehicle to the nearest hospital. Directions describing the route to the hospital are provided in Section 14.10.

If a worker leaves the site to seek medical attention, another worker should accompany them to the hospital. When in doubt about the severity of an injury or exposure, always seek medical attention as a conservative approach and notify the PEC.

The PEC will be responsible for completing all accident/incident field reports, OSHA Form 200s, and other required follow-up forms.

14.8 OVERT PERSONAL EXPOSURE OR INJURY

If an overt exposure to toxic materials occurs, the first responder to the victim will initiate actions to address the situation. The following actions should be taken, depending on the type of exposure.

14.8.1 Skin contact

- Wash/rinse the affected area thoroughly with copious amounts of soap and water.
- If eye contact has occurred, rinse eyes for at least 15 minutes using the eyewash that is part of the onboard emergency equipment.
- After initial response actions have been taken, seek appropriate medical attention.

14.8.2 Inhalation

- Move victim to fresh air.
- Seek appropriate medical attention.

14.8.3 Ingestion

- Seek appropriate medical attention.

14.8.4 Puncture wound or laceration

- Seek appropriate medical attention.

14.9 SPILLS AND SPILL CONTAINMENT

No bulk chemicals or other materials subject to spillage are expected to be used during this project. Accordingly, no spill containment procedure is required for this project.

14.10 EMERGENCY ROUTE TO THE HOSPITAL AND HYPERBARIC CHAMBER

The name, address, and telephone number of the hospital that will be used to provide medical care is as follows:

Harborview Medical Center
325 Ninth Avenue
Seattle, WA
(206) 323-3074

Directions from the Harbor Island Marina to Harborview Medical Center (Figure 1) are as follows:

- Dock the vessel at the Harbor Island Marina
- Drive from the marina by heading west on SW Klickitat Way/SW Manning St.

- Turn right toward SW Manning St.
- Turn right at SW Manning St.
- Take the WA-99 N ramp on the left to I-5 N/Columbian Way
- Head north on I-5
- Take exit 164A for James St.
- Head east on James St. to Ninth Ave.
- Turn right on Ninth Ave.
- Emergency entrance will be two blocks south on the right.

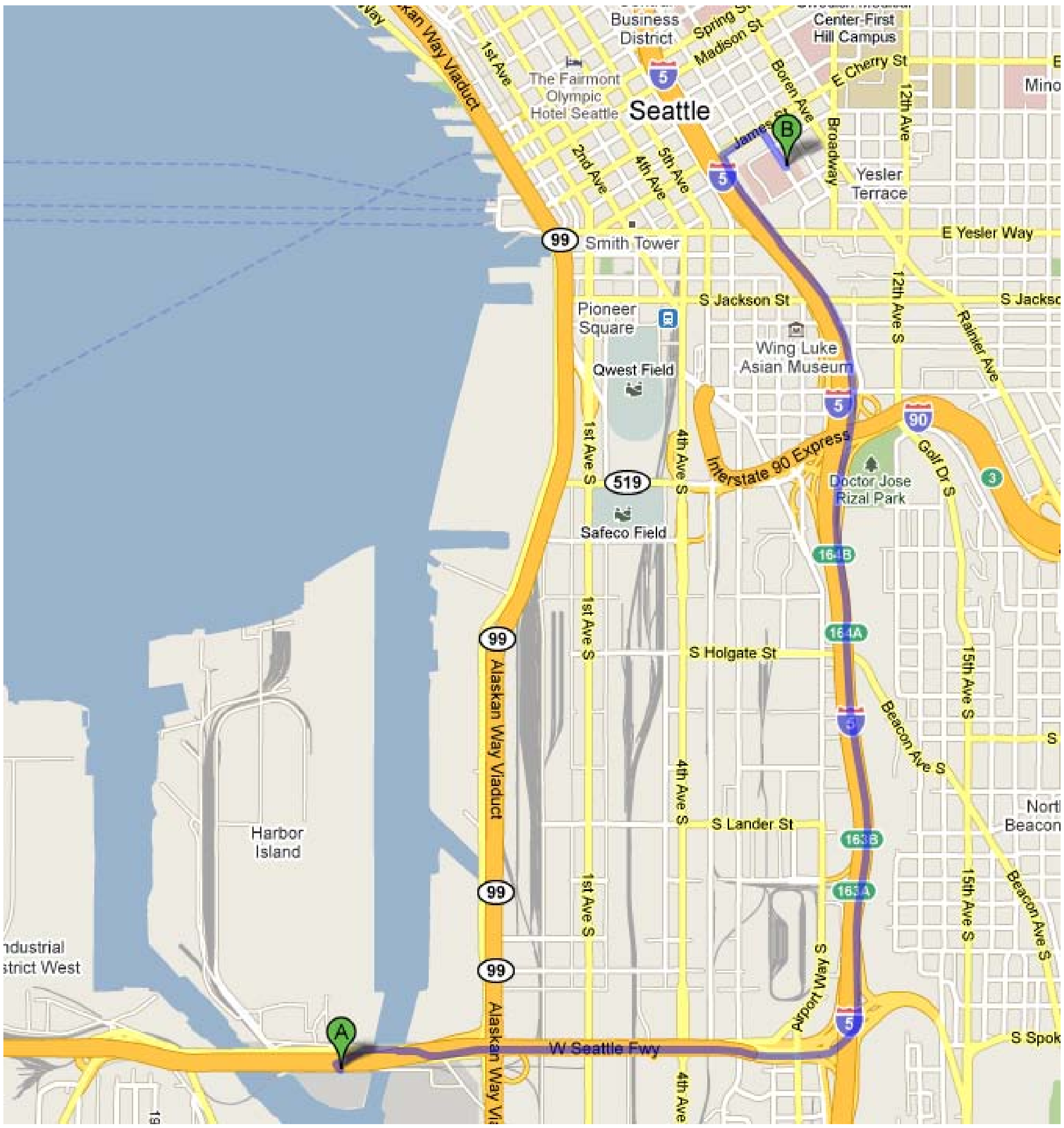


Figure 1. Directions to Harborview Medical Center from the Harbor Island Marina

Directions from the Jack Perry Memorial Shoreline Access to Harborview Medical Center (Figure 2) are as follows:

- Beach the vessel at the Jack Perry Memorial Shoreline
- Drive east from the shoreline on the access road
- Turn left on Alaskan Way S.
- After 0.9 miles turn right on Yesler Way
- After 0.7 miles turn left on 8th Ave.
- Take first left on 9th Ave.
- Cross Alder St. and the emergency entrance will be on the left.

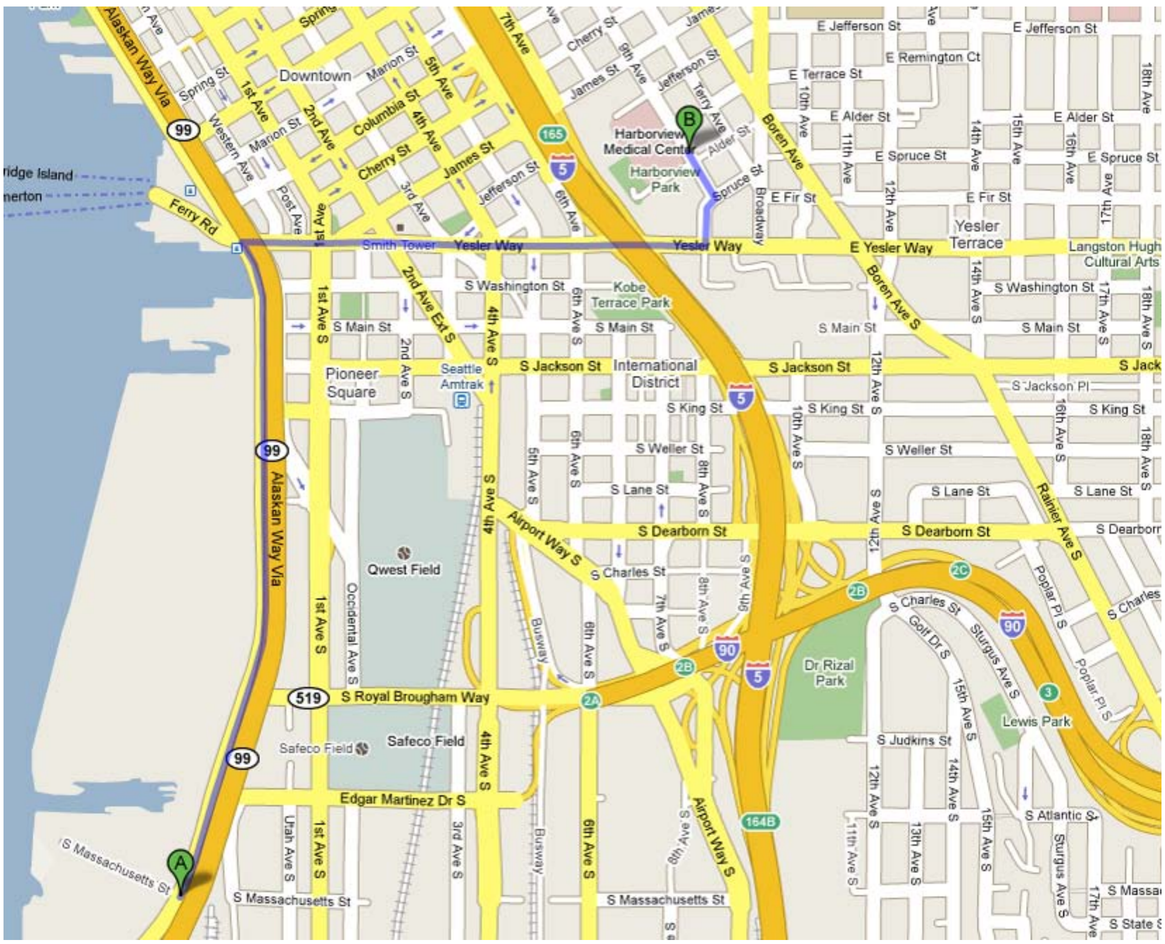


Figure 2. Directions to Harborview Medical Center from Jack Perry Memorial Shoreline Access

In the event of a hyperbaric medical emergency, emergency services should be immediately notified by dialing 911. The name, address, and telephone number of the nearest hyperbaric chamber is as follows:

Center for Hyperbaric Medicine at Virginia Mason Medical Center
1100 Ninth Avenue
Seattle, WA
(206) 583-6543

Directions from the Harbor Island Marina to the Center for Hyperbaric Medicine (Figure 3) are as follows:

- Dock the vessel at the Harbor Island Marina
- Drive from the marina by heading west on SW Klickitat Way/SW Manning St.
- Turn right toward SW Manning St.
- Turn right at SW Manning St.
- Take the WA-99 N ramp on the left to I-5 N/Columbian Way
- Head north on I-5
- Take exit 164A toward James St.
- Merge onto 7th Ave.
- Turn right onto Spring St.
- Turn left onto 9th Ave.
- Hospital will be on the right.

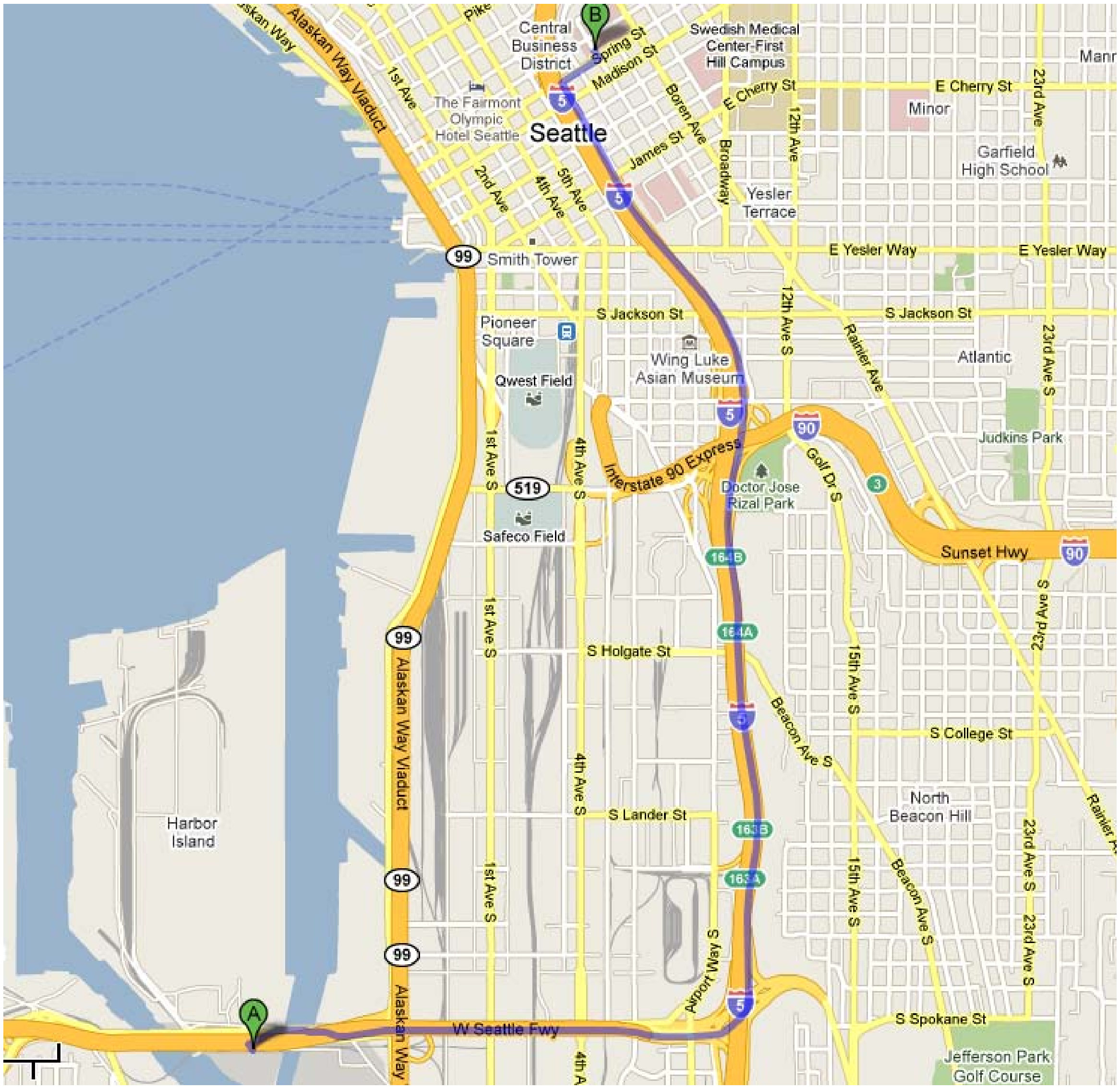


Figure 3. Directions to the Center for Hyberbaric Medicine from the Harbor Island Marina

Directions from the Jack Perry Memorial Shoreline Access to the Center for Hyperbaric Medicine (Figure 4) are as follows:

- Beach the vessel at the Jack Perry Memorial Shoreline
- Drive east from the shoreline on the access road
- Turn left on Alaskan Way S.
- After 1.2 miles turn right onto Spring St.
- After 0.6 miles turn left on 9th Ave.
- Hospital will be on the right

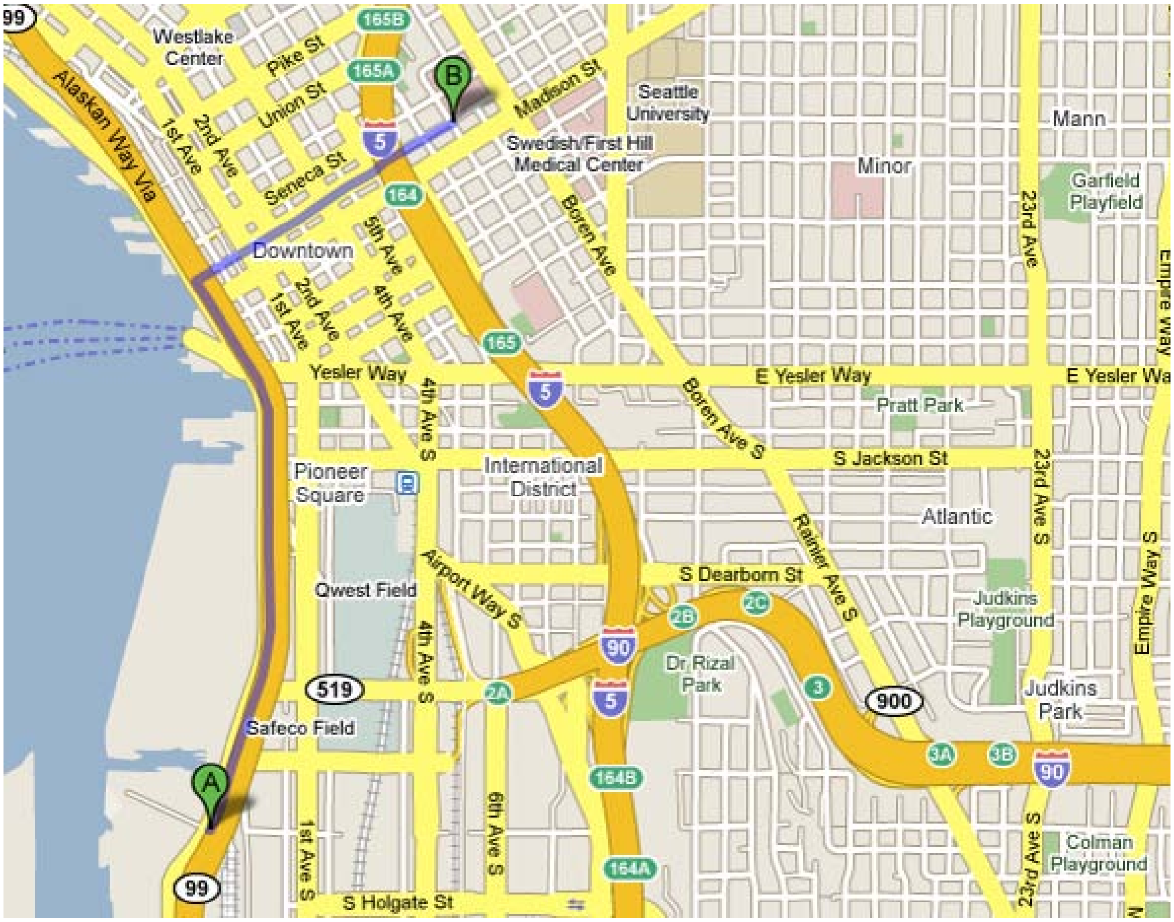


Figure 4. Directions to the Center for Hyberbaric Medicine from Jack Perry Memorial Shoreline Access

15 References

PSEP. 1997. Recommended guidelines for sampling marine sediment, water column, and tissue in Puget Sound. Final Report. Prepared for the U.S. Environmental Protection Agency, Seattle, Washington, and the Puget Sound Water Quality Action Team, Olympia, WA.

Attachment 1. Safe Practices Manual for Diving Operations

Attachment 2. Field Team Health and Safety Plan Review

I have read a copy of the health and safety plan, which covers field activities that will be conducted to investigate potentially contaminated areas in the EW. I understand the health and safety requirements of the project, which are detailed in this health and safety plan.

Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date

APPENDIX B

Field Collection Forms

MUDMOLE™ BORE LOG

Project: **Station:**

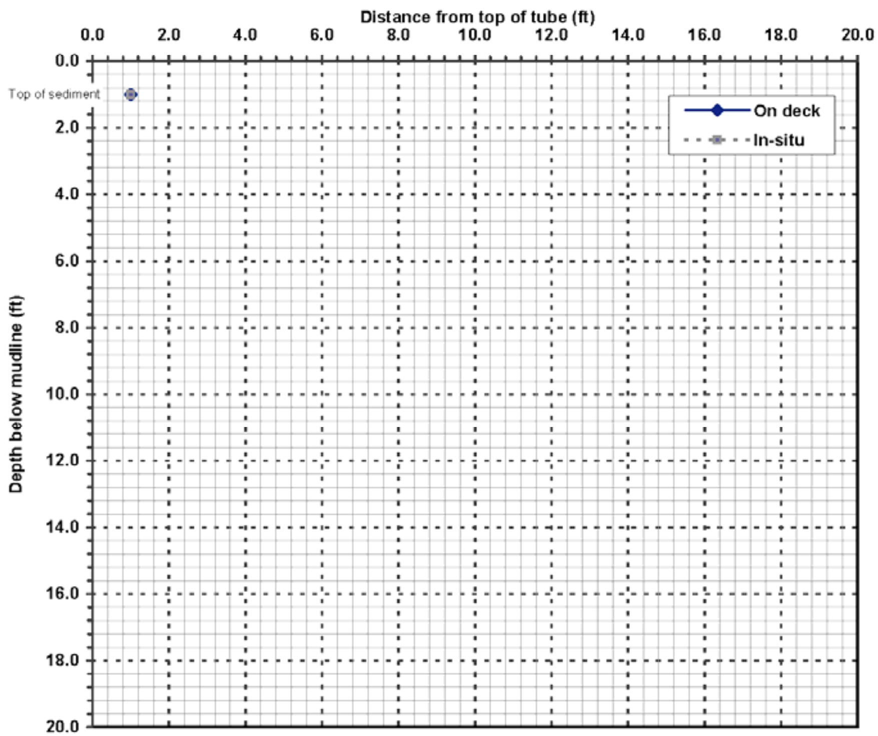
Collected by:

Date: **Time:**

Water depth: ft **Mudline:** ft MLLW (estimated using tide tables)

Place Field ID Label Here

Weather/Comments:



Penetration 20 ft / On-deck Recovery 20 ft = 100% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	0
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

ANCHOR QEA

Sediment Core Collection Log

Page __ of __

Job: ______________________ **Station ID:** ______________________

Job No: ______________________ **Attempt No.** ______________________

Field Staff: ______________________ **Date:** ______________________

Contractor: ______________________ **Logged By:** ______________________

Vertical Datum: ______________________ **Horizontal Datum:** ______________________

Field Collection Coordinates:

Lat/Northing: ______________________ Long/Easting: ______________________

A. Water Depth

DTM Depth Sounder: ______________________

DTM Lead Line: ______________________

B. Tide Measurements

Time: ______________________

Height: ______________________

C. Mudline Elevation

______________________ (-A+B=C)

Core Collection Recovery Details:

Core Accepted: Yes / No

Core Tube Length: ______________________

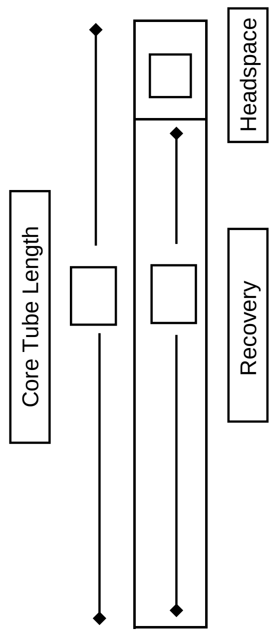
Drive Penetration: ______________________

Headspace Measurement: ______________________

Recovery Measurement: ______________________

Recovery Percentage: ______________________

Total Length of Core To Process: ______________________



Drive Notes:

Core Field Observations and Description:	Sediment type, moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota

Samples Collected (i.e. rinsate blank)

Sediment Core Processing Log

Job:	Station ID:
Job No.	Date/Time:
No. of Sections:	Core Logged By:
Drive Length:	Attempt #:
Recovery:	Type of Core ☐Shelby ☐Piston Core ☐Other
% Recovery:	Diameter of Core (inches)
Notes:	Core Quality ☐Good ☐Fair ☐Poor ☐ Disturbed

Recovered Length (ft)	Size % G	Size % S	Size % F	PID	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Sample	Subsample	Summary Sketch

Windward environmental LLC

PROTOCOL MODIFICATION FORM

Project Name and Number: ______________________

Material to be Sampled: ______________________

Measurement Parameter: ______________________

____

____

____

____

Standard Procedure for Field Collection & Laboratory Analysis (cite reference):

____

____

____

____

Reason for Change in Field Procedure or Analysis Variation: ______________________

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____

Variation from Field or Analytical Procedure: ______________________

____

____

____

____

Special Equipment, Materials or Personnel Required: ______________________

____

____

____

____

Initiator's Name: ______________________ Date: __________

Project Officer: ______________________ Date: __________

QA Officer: ______________________ Date: __________

APPENDIX C

Laboratory Method Detection Limits and Reporting Limits

Appendix C. Laboratory Method Detection Limits and Reporting Limits

Table C-1. Target MDLs and RLs (mg/kg)

Chemical	MDL[a]	RL[a]
Metals (EPA 6010B/200.8/7471A)		
Antimony	0.38	5
Arsenic	0.17	0.5
Cadmium	0.02	0.2
Chromium	0.28	0.5
Cobalt	0.09	0.3
Copper	0.043	0.5
Lead	0.2	2
Mercury	0.005	0.05
Molybdenum	0.15	0.5
Nickel	0.31	1
Selenium	0.671	2
Silver	0.11	0.3
Thallium	0.005	0.2
Vanadium	0.04	0.3
Zinc	0.443	4.0
Organometals (Krone 1989)		
Monobutyltin ion	0.0041	0.0040
Dibutyltin ion	0.0032	0.0060
Tributyltin ion	0.0012	0.0040
PAHs (EPA 8270D)		
1-Methylnaphthalene	0.0072	0.020
2-Methylnaphthalene	0.0082	0.020
Acenaphthylene	0.0087	0.020
Acenaphthene	0.0082	0.020
Anthracene	0.0077	0.020
Benzo(a)anthracene	0.0059	0.020
Benzo(a)pyrene	0.0082	0.020
Benzo(b)fluoranthene	0.0095	0.020
Benzo(g,h,i)perylene	0.0068	0.020
Benzo(k)fluoranthene	0.0093	0.020
Total benzofluoranthenes[b]	0.0095	0.020
Chrysene	0.0066	0.020
Dibenzo(a,h)anthracene	0.0086	0.020
Dibenzofuran	0.0076	0.020
Fluoranthene	0.0079	0.020
Fluorene	0.0090	0.020
Indeno(1,2,3-cd)pyrene	0.0086	0.020
Naphthalene	0.0087	0.020
Phenanthrene	0.0084	0.020

Chemical	MDL[a]	RL[a]
Pyrene	0.0078	0.020
Total LPAHs[c]	0.0090	0.020
Total HPAHs[d]	0.0095	0.020
Phthalates (EPA 8270D)		
Bis(2-ethylhexyl)phthalate	0.011	0.020
Butyl benzyl phthalate	0.011	0.020
Di-ethyl phthalate	0.016	0.020
Dimethyl phthalate	0.0078	0.020
Di-n-butyl phthalate	0.012	0.020
Di-n-octyl phthalate	0.0083	0.020
Other SVOCs (EPA 8270D)		
1,2,4-Trichlorobenzene	0.0091	0.020
1,2-Dichlorobenzene	0.0079	0.020
1,3-Dichlorobenzene	0.0075	0.020
1,4-Dichlorobenzene	0.0074	0.020
2,4,5-Trichlorophenol	0.045	0.10
2,4,6-Trichlorophenol	0.046	0.10
2,4-Dichlorophenol	0.041	0.10
2,4-Dimethylphenol	0.015	0.020
2,4-Dinitrophenol	0.11	0.20
2,4-Dinitrotoluene	0.039	0.10
2,6-Dinitrotoluene	0.054	0.10
2-Chloronaphthalene	0.0080	0.020
2-Chlorophenol	0.0075	0.020
2-Methylphenol	0.014	0.020
3,3'-Dichlorobenzidine	0.049	0.10
4-Chloroaniline	0.035	0.10
4-Methylphenol	0.013	0.020
Aniline	0.067	0.067
Benzoic acid	0.12	0.20
Benzyl alcohol	0.015	0.020
Bis(2-chloroethyl)ether	0.0075	0.020
Bis-chloroisopropyl ether	0.0080	0.020
Carbazole	0.0066	0.020
Hexachlorobenzene	0.0080	0.020
Hexachlorobutadiene	0.0081	0.020
Hexachloroethane	0.0072	0.020
Isophorone	0.0083	0.020
Nitrobenzene	0.0088	0.020
N-Nitrosodimethylamine	0.035	0.10
N-Nitrosodi-n-propylamine	0.036	0.10
N-Nitrosodiphenylamine	0.0087	0.020
Pentachlorophenol	0.048	0.10
Phenol	0.014	0.020
Selected SVOCs by EPA 8270D-SIM		
1,2,4-Trichlorobenzene	0.0016	0.0067
1,2-Dichlorobenzene	0.0013	0.0067

Chemical	MDL[a]	RL[a]
1,4-Dichlorobenzene	0.0022	0.0067
2,4-Dimethylphenol	0.0039	0.0067
2-Methylphenol	0.0034	0.0067
Benzyl alcohol	0.016	0.033
Butyl benzyl phthalate	0.0040	0.0067
Dibenzo(a,h)anthracene	0.00050	0.0063
Dimethyl phthalate	0.0017	0.0065
Hexachlorobenzene	0.0020	0.0067
Hexachlorobutadiene	0.0029	0.0067
N-Nitrosodiphenylamine	0.0031	0.0067
N-Nitrosodimethylamine	0.024	0.033
N-Nitrosodi-n-propylamine	0.0027	0.033
Pentachlorophenol	0.013	0.033
PCBs		
Aroclor 1016	0.0013	0.0040
Aroclor 1221	0.0013	0.0040
Aroclor 1232	0.0013	0.0040
Aroclor 1242	0.0028	0.0040
Aroclor 1248	0.0028	0.0040
Aroclor 1254	0.0028	0.0040
Aroclor 1260	0.0028	0.0040
Total PCBs[e]	0.0028	0.0040
Dioxins/furans (EPA 1613B)		
2,3,7,8-TCDD	7.40E-08	5.0E-07
1,2,3,7,8-PeCDD	2.10E-07	2.5E-06
1,2,3,4,7,8-HxCDD	2.60E-07	2.5E-06
1,2,3,6,7,8-HxCDD	2.90E-07	2.5E-06
1,2,3,7,8,9-HxCDD	2.48E-07	2.5E-06
1,2,3,4,6,7,8-HpCDD	2.80E-07	2.5E-06
OCDD	3.88E-07	5.0E-06
2,3,7,8-TCDF	7.80E-08	5.0E-07
1,2,3,7,8-PeCDF	1.82E-07	2.5E-06
2,3,4,7,8-PeCDF	2.38E-07	2.5E-06
1,2,3,4,7,8-HxCDF	2.22E-07	2.5E-06
1,2,3,6,7,8-HxCDF	2.06E-07	2.5E-06
1,2,3,7,8,9-HxCDF	2.52E-07	2.5E-06
2,3,4,6,7,8-HxCDF	2.40E-07	2.5E-06
1,2,3,4,6,7,8-HpCDF	3.28E-07	2.5E-06
1,2,3,4,7,8,9-HpCDF	2.98E-07	2.5E-06
OCDF	6.22E-07	5.0E-06
Pesticides (EPA 8081A)		
2,4'-DDD	0.0012	0.0020
2,4'-DDE	0.00093	0.0020
2,4'-DDT	0.0010	0.0020
4,4'-DDD	0.0013	0.0020

Chemical	MDL[a]	RL[a]
4,4'-DDE	0.0012	0.0020
4,4'-DDT	0.00088	0.0020
Total DDTs[f]	0.0013	0.0020
Aldrin	0.00048	0.0010
alpha-BHC	0.00062	0.0010
beta-BHC	0.00039	0.0010
delta-BHC	0.00043	0.0010
alpha-Chlordane	0.00061	0.0010
Total chlordane[g]	0.0010	0.0020
Dieldrin	0.00084	0.0020
alpha-Endosulfan	0.00067	0.0010
beta-Endosulfan	0.0012	0.0020
Endosulfan sulfate	0.00088	0.0020
Endrin	0.0012	0.0020
Endrin aldehyde	0.00098	0.0020
Endrin ketone	0.0016	0.0020
gamma-BHC (Lindane)	0.00049	0.0010
Heptachlor	0.00040	0.0010
Heptachlor epoxide	0.00038	0.0010
Methoxychlor	0.0033	0.010
Mirex	0.0010	0.0020
Cis-nonachlor	0.00082	0.0020
Trans-nonachlor	0.0010	0.0020
Oxychlordane	0.00095	0.0020
Toxaphene	0.048	0.10

na – not available
MDL – method detection limit
PCB – polychlorinated biphenyl
RL – reporting limit
SIM – selected ion monitoring
SVOCs – semi-volatile organic compounds
VOC – volatile organic compounds

[a] Target RLs and MDLs are the most recent values provided by ARI and Analytical Perspectives. Actual RLs and MDLs will vary based on amount of sample analyzed, matrix interferences, analytical dilution, percent solids of the sample and/or updates to RLs and MDLs by the laboratory. The MDLs provided for dioxin congeners are the average MDLs of sample-specific detection limits, calculated from specific samples over 4-6 years

[b] Total benzofluoranthenes is the sum of benzo(b)fluoranthene and benzo(k)fluoranthene. RL and MDL are the highest of the RLs and MDLs for benzo(b)fluoranthene or benzo(k)fluoranthene.

[c] Total LPAHs is the sum of naphthalene, 2-methyl naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. RL and MDL are the highest RL and MDL for the LPAHs.

[d] Total HPAHs is the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene. RL and MDL are the highest RL and MDL for the HPAHs.

[e] Total PCBs is the sum of the Aroclors. RL and MDL are the highest RL and MDL for the individual Aroclors.

[f] Total DDT is the sum of 4,4'-DDD, 4,4-DDE, 4,4'-DDT, 2,4'-DDD, 2,4-DDE, and 2,4'-DDT. RL and MDL are the highest RL and MDL for the DDT isomers.

[g] Total chlordane is the sum of oxychlordane, alpha- and gamma-chlordane, and cis- and trans-nonachlor. RL and MDL are the highest RL and MDL for the chlordane-related compounds.

APPENDIX D

Historical Subsurface Sediment Locations and SQS or CSL Exceedances

Appendix D Historical Surface Sediment Locations and SQS or CSL Exceedances

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
1362	0	125	> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	1.5	0.15
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	2.9	0.54
1366	0	168	> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	2	**1.2**
			> SQS/SL, ≤CSL/ML, Detect	Butyl benzyl phthalate	1.5	0.11
			> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	5.8	0.58
			> SL, Detect (no ML)	Dieldrin	2.3	
			> CSL/ML, Detect	Mercury	1.6	**1.1**
			> CSL/ML, Detect	PCBs (total calc'd)	7.9	**1.5**
			> SL, Detect (no ML)	Total Chlordane (calc'd)	1.3	
1391	0	122	> CSL/ML, Detect	Mercury	1.7	**1.2**
1392	0	122	> CSL/ML, Detect	Mercury	2.7	**1.9**
1395	0	122	> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.5	0.88
			> SQS/SL, ≤CSL/ML, Detect	Butyl benzyl phthalate	1	0.078
			> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	4.3	0.43
			> SL, Detect (no ML)	Dieldrin	1.4	
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.4	**1**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3	0.55
1396	0	122	> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.9	**1.1**
			> SQS/SL, ≤CSL/ML, Detect	Butyl benzyl phthalate	1.2	0.094
			> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	6.1	0.61
			> SL, Detect (no ML)	Dieldrin	2.3	
			> CSL/ML, Detect	Mercury	1.5	**1**
			> CSL/ML, Detect	PCBs (total calc'd)	7.3	**1.3**
			> SL, Detect (no ML)	Total Chlordane (calc'd)	1.1	
1410	0	122	> CSL/ML, Detect	Mercury	2.2	**1.5**
1412	0	122	> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.6	0.96
			> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	5.2	0.52
			> SL, Detect (no ML)	Dieldrin	1.8	
			> CSL/ML, Detect	Mercury	1.7	**1.2**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3.9	0.72
1565	0	122	> CSL/ML, Detect	PCBs (total calc'd)	20	**3.7**
1602	0	122	> CSL/ML, Detect	PCBs (total calc'd)	13	**2.3**
1603	122	244	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.83
1610	0	111	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	4	0.74
1611	0	120	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.3	0.23
1613	0	108	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.2	0.22

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
1614	0	122	> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1	0.63
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.3	0.88
			> CSL/ML, Detect	PCBs (total calc'd)	8.3	**1.5**
1615	0	117	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	4.2	0.77
1616	0	110	> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	1.2	0.12
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.83
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.3	0.25
1617	0	122	> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	1.7	0.17
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.3	0.87
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	2.1	0.38
1618	0	105	> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.1	0.67
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.4	0.97
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	4	0.74
1619	0	113	> CSL/ML, Detect	Mercury	2.4	**1.7**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3.5	0.65
1620	0	116	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.3	0.89
			> CSL/ML, Detect	PCBs (total calc'd)	11	**2**
1621	0	116	> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.6	0.99
			> CSL/ML, Detect	Mercury	1.6	**1.1**
			> CSL/ML, Detect	PCBs (total calc'd)	5.6	**1**
1622	0	113	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.85
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3.7	0.68
1623	0	102	> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.1	0.64
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.4	0.95
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	4.8	0.88
1624	0	110	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.8
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3.1	0.57
1625	0	98	> CSL/ML, Detect	Mercury	1.5	**1**
			> CSL/ML, Detect	PCBs (total calc'd)	6.4	**1.2**
			> SL, Detect (no ML)	Total Chlordane (calc'd)	5	
1626	0	105	> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.8	**1.1**
			> SQS/SL, ≤CSL/ML, Detect	Butyl benzyl phthalate	1	0.078
			> CSL/ML, Detect	Mercury	1.5	**1**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	5.1	0.94
1628	0	91	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3.8	0.69
1629	0	102	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	2.8	0.51
1630	0	88	> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.2	0.72
			> CSL/ML, Detect	PCBs (total calc'd)	7.5	**1.4**
1633	0	122	> SQS/SL, ≤CSL/ML, Detect	Acenaphthene	1.1	0.32
			> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.5	0.92

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
			> CSL/ML, Detect	Cadmium	2.5	**1.9**
			> CSL/ML, Detect	DDTs (total-calc'd)	72	**7.2**
			> CSL/ML, Detect	Mercury	1.5	**1**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	5.3	0.98
			> CSL/ML, Detect	Zinc	7.1	**3**
1639	0	116	> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	2.9	0.29
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.83
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	2	0.37
1644	0	108	> SQS/SL, ≤CSL/ML, Detect	Acenaphthene	1.3	0.35
			> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.4	0.86
			> CSL/ML, Detect	Mercury	1.8	**1.3**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	5	0.92
1646	0	119	> CSL/ML, Detect	2,4-Dimethylphenol	22	**22**
			> CSL/ML, Detect	2-Methylnaphthalene	3.1	**1.5**
			> CSL/ML, Detect	Acenaphthene	1.6	**1.1**
			> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	3	**2.1**
			> SQS/SL, ≤CSL/ML, Detect	Cadmium	1.1	0.82
			> CSL/ML, Detect	DDTs (total-calc'd)	14	**1.4**
			> SQS/SL, ≤CSL/ML, Detect	Ethylbenzene	2.4	0.48
			> SQS/SL, ≤CSL/ML, Detect	Fluoranthene	1.4	0.96
			> SQS/SL, ≤CSL/ML, Detect	Fluorene	1.1	0.62
			> CSL/ML, Detect	Mercury	1.6	**1.1**
			> CSL/ML, Detect	Naphthalene	5.7	**5**
			> CSL/ML, Detect	PCBs (total calc'd)	42	**5.4**
			> SQS/SL, ≤CSL/ML, Detect	Phenanthrene	1.6	0.44
			> CSL/ML, Detect	Total LPAH (calc'd)	3.1	**1.2**
			> SQS/SL, ≤CSL/ML, Detect	Total Xylenes (calc'd)	1.4	0.35
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.5	0.65
1648	0	119	> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	1.7	0.17
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.8	0.32
1654	0	107	> CSL/ML, Detect	Mercury	1.7	**1.2**
1655	0	88	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.6	0.29
1656	0	88	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	2.1	0.38
1657	0	104	> CSL/ML, Detect	1,2-Dichlorobenzene	2.4	**1.7**
			> SQS/SL, ≤CSL/ML, Detect	2-Methylnaphthalene	1.3	0.63
			> CSL/ML, Detect	Benzo(g,h,i)perylene	2.4	**2.2**
			> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	10	**6.8**
			> SQS/SL, ≤CSL/ML, Detect	Butyl benzyl phthalate	5.6	0.39
			> SQS/SL, ≤CSL/ML, Detect	Chrysene	1.1	0.54
			> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	5.9	0.59
			> SQS/SL, ≤CSL/ML, Detect	Dibenzo(a,h)anthracene	1.9	0.8

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
			> CSL/ML, Detect	Dimethyl phthalate	12	**5.5**
			> CSL/ML, Detect	Fluoranthene	1.9	**1.3**
			> CSL/ML, Detect	Indeno(1,2,3-cd)pyrene	2.3	**2**
			> CSL/ML, Detect	Mercury	2.3	**1.6**
			> CSL/ML, Detect	PCBs (total calc'd)	17	**2.2**
			> SQS/SL, ≤CSL/ML, Detect	Pyrene	1.2	0.97
			> CSL/ML, Detect	Silver	1.6	**1.6**
			> SQS/SL, ≤CSL/ML, Detect	Total HPAH (calc'd)	1.3	0.93
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.2	0.52
1658	0	110	> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.3	0.81
			> CSL/ML, Detect	Mercury	2.8	**2**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3.2	0.58
1659	0	119	> SQS/SL, ≤CSL/ML, Detect	Acenaphthene	3.4	0.96
			> SQS/SL, ≤CSL/ML, Detect	Benzo(g,h,i)perylene	1.6	0.64
			> SQS/SL, ≤CSL/ML, Detect	Dibenzo(a,h)anthracene	2.3	0.82
			> SQS/SL, ≤CSL/ML, Detect	Dibenzofuran	2.3	0.59
			> SQS/SL, ≤CSL/ML, Detect	Fluoranthene	1.8	0.24
			> SQS/SL, ≤CSL/ML, Detect	Fluorene	2.6	0.75
			> SQS/SL, ≤CSL/ML, Detect	Indeno(1,2,3-cd)pyrene	1.5	0.57
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.3	0.88
			> CSL/ML, Detect	PCBs (total calc'd)	7.2	**1.3**
			> SQS/SL, ≤CSL/ML, Detect	Phenanthrene	3.8	0.79
			> SQS/SL, ≤CSL/ML, Detect	Total HPAH (calc'd)	1.3	0.23
			> SQS/SL, ≤CSL/ML, Detect	Total LPAH (calc'd)	1.7	0.82
			> SQS/SL, ≤CSL/ML, Detect	Zinc	2	0.85
1660	0	113	> SQS/SL, ≤CSL/ML, Detect	2-Methylnaphthalene	1	0.5
			> CSL/ML, Detect	Acenaphthene	2.4	**1.6**
			> SQS/SL, ≤CSL/ML, Detect	Benzo(a)anthracene	1.1	0.88
			> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	3.4	**2.3**
			> SQS/SL, ≤CSL/ML, Detect	Cadmium	1.3	**1**
			> SQS/SL, ≤CSL/ML, Detect	Chrysene	1.5	0.75
			> CSL/ML, Detect	DDTs (total-calc'd)	10	**1**
			> CSL/ML, Detect	Dibenzofuran	1.6	**1.2**
			> CSL/ML, Detect	Fluoranthene	2.6	**1.8**
			> CSL/ML, Detect	Fluorene	2	**1.1**
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.1	0.8
			> CSL/ML, Detect	PCBs (total calc'd)	33	**4.3**
			> SQS/SL, ≤CSL/ML, Detect	Phenanthrene	2.9	0.8
			> CSL/ML, Detect	Pyrene	2.1	**1.6**
			> CSL/ML, Detect	Total HPAH (calc'd)	1.5	**1.1**
			> SQS/SL, ≤CSL/ML, Detect	Total LPAH (calc'd)	1.7	0.69

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.6	0.7
1661	0	111	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.6	0.29
1662	0	116	> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	4	**2.4**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.3	0.25
1663	0	119	> SQS/SL, ≤CSL/ML, Detect	1,4-Dichlorobenzene	1.3	0.43
			> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	2	**1.2**
1674	98	268	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.1	0.79
1676	101	250	> CSL/ML, Detect	Mercury	1.6	**1.1**
			> CSL/ML, Detect	Mercury	1.8	**1.3**
			> CSL/ML, Detect	PCBs (total calc'd)	8.3	**1.5**
			> CSL/ML, Detect	PCBs (total calc'd)	30	**3.9**
1679	104	259	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.5	0.28
1682	116	341	> CSL/ML, Detect	Copper	1.9	**1.9**
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.85
			> CSL/ML, Detect	Silver	1.1	**1.1**
1683	94	399	> SQS/SL, ≤CSL/ML, Detect	DDTs (total-calc'd)	2.2	0.22
			> CSL/ML, Detect	Mercury	1.6	**1.1**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3.8	0.71
1687	119	216	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.2	0.22
1927	122	366	> SQS/SL, ≤CSL/ML, Detect	Acenaphthene	1.4	0.4
			> SQS/SL, ≤CSL/ML, Detect	Dibenzofuran	1.3	0.34
1929	0	122	> CSL/ML, Detect	DDTs (total-calc'd)	32	**3.2**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	4.5	0.83
	122	366	> CSL/ML, Detect	DDTs (total-calc'd)	11	**1.1**
2082	122	366	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.84
2251	15	46	> CSL/ML, Detect	1,4-Dichlorobenzene	5.2	**1.8**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3.1	0.57
	18	46	> CSL/ML, Detect	1,4-Dichlorobenzene	4.9	**4.5**
			> CSL/ML, Detect	PCBs (total calc'd)	11	**1.4**
	46	76	> SQS/SL, ≤CSL/ML, Detect	1,4-Dichlorobenzene	1.6	0.54
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.2	0.22
2254	15	46	> CSL/ML, Detect	Mercury	1.6	**1.1**
			> CSL/ML, Detect	PCBs (total calc'd)	17	**2.2**
	46	76	> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	2.9	**2**
			> SQS/SL, ≤CSL/ML, Detect	Fluoranthene	1.3	0.88
			> CSL/ML, Detect	Mercury	3.7	**2.5**
			> CSL/ML, Detect	PCBs (total calc'd)	22	**2.8**
			> CSL/ML, Detect	Silver	1.1	**1.1**
	76	107	> CSL/ML, Detect	Mercury	2.5	**1.8**
2255	15	46	> SQS/SL, ≤CSL/ML, Detect	Anthracene	3.4	0.75

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
			> CSL/ML, Detect	Benzo(a)anthracene	4.1	**3.3**
			> CSL/ML, Detect	Benzo(a)pyrene	2.1	**1.1**
			> CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	1.7	**1.5**
			> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.8	**1.3**
			> CSL/ML, Detect	Chrysene	6.4	**3.2**
			> CSL/ML, Detect	Fluoranthene	4.2	**2.9**
			> CSL/ML, Detect	Mercury	1.6	**1.1**
			> CSL/ML, Detect	PCBs (total calc'd)	12	**1.5**
			> CSL/ML, Detect	Pyrene	4.6	**3.6**
			> CSL/ML, Detect	Total HPAH (calc'd)	3.6	**2.5**
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.3	0.55
	46	76	> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.9	**1.1**
			> SQS/SL, ≤CSL/ML, Detect	Chrysene	1.5	0.35
			> SQS/SL, ≤CSL/ML, Detect	Fluoranthene	2.9	0.39
			> CSL/ML, Detect	Mercury	3	**2.1**
			> CSL/ML, Detect	PCBs (total calc'd)	6	**1.1**
			> SQS/SL, ≤CSL/ML, Detect	Total HPAH (calc'd)	1.4	0.25
	76	107	> CSL/ML, Detect	Acenaphthene	2.6	**1.8**
			> SQS/SL, ≤CSL/ML, Detect	Anthracene	2.5	0.55
			> CSL/ML, Detect	Benzo(a)anthracene	2.2	**1.8**
			> CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	1.2	**1**
			> CSL/ML, Detect	Chrysene	2.6	**1.3**
			> CSL/ML, Detect	Fluoranthene	5.9	**4**
			> SQS/SL, ≤CSL/ML, Detect	Fluorene	1.7	0.91
			> CSL/ML, Detect	Indeno(1,2,3-cd)pyrene	1.2	**1**
			> CSL/ML, Detect	Mercury	2.7	**1.8**
			> CSL/ML, Detect	PCBs (total calc'd)	9.3	**1.2**
			> SQS/SL, ≤CSL/ML, Detect	Phenanthrene	1.3	0.35
			> CSL/ML, Detect	Pyrene	2.6	**2.1**
			> CSL/ML, Detect	Total HPAH (calc'd)	2.5	**1.8**
			> SQS/SL, ≤CSL/ML, Detect	Total LPAH (calc'd)	1.3	0.5
2256	15	46	> CSL/ML, Detect	1,4-Dichlorobenzene	1.4	**1.3**
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.3	0.93
			> CSL/ML, Detect	PCBs (total calc'd)	7.8	**1**
2257	15	46	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.4	0.98
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.2	0.22
	46	76	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.83
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.8	0.32
	76	107	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.86
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.1	0.2

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
2258	15	46	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.1	0.2
	46	76	> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.3	0.79
			> SQS/SL, ≤CSL/ML, Detect	Mercury	1.1	0.75
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	2.8	0.52
	76	107	> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	2.6	**1.5**
			> CSL/ML, Detect	Mercury	1.7	**1.2**
			> CSL/ML, Detect	PCBs (total calc'd)	16	**2.9**
2259	15	46	> CSL/ML, Detect	Mercury	1.7	**1.2**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	3	0.55
	46	76	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.1	0.8
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.8	0.32
2260	15	46	> CSL/ML, Detect	Mercury	2.9	**2**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	5.1	0.94
	46	76	> SQS/SL, ≤CSL/ML, Detect	Anthracene	2.3	0.5
			> CSL/ML, Detect	Benzo(a)anthracene	3.1	**2.5**
			> SQS/SL, ≤CSL/ML, Detect	Benzo(a)pyrene	1.5	0.8
			> CSL/ML, Detect	Benzo(g,h,i)perylene	1.6	**1.5**
			> CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	1.9	**1.7**
			> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	2.2	**1.5**
			> CSL/ML, Detect	Chrysene	3.7	**1.9**
			> CSL/ML, Detect	DDTs (total-calc'd)	39	**3.9**
			> CSL/ML, Detect	Fluoranthene	9.4	**6.4**
			> CSL/ML, Detect	Indeno(1,2,3-cd)pyrene	1.8	**1.6**
			> CSL/ML, Detect	Mercury	4.8	**3.3**
			> CSL/ML, Detect	PCBs (total calc'd)	26	**3.4**
			> CSL/ML, Detect	Pyrene	3.8	**3**
			> CSL/ML, Detect	Silver	1.2	**1.2**
			> CSL/ML, Detect	Total HPAH (calc'd)	3.8	**2.7**
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.1	0.48
	76	107	> CSL/ML, Detect	4-Methylphenol	1.3	**1.3**
			> CSL/ML, Detect	Acenaphthene	22	**15**
			> CSL/ML, Detect	Anthracene	10	**2.2**
			> CSL/ML, Detect	Benzo(a)anthracene	6.1	**4.9**
			> CSL/ML, Detect	Benzo(a)pyrene	2.6	**1.4**
			> CSL/ML, Detect	Benzo(g,h,i)perylene	1.9	**1.8**
			> CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	3.1	**2.8**
			> SQS/SL, ≤CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	1.1	0.74
			> CSL/ML, Detect	Chrysene	6.7	**3.4**
			> CSL/ML, Detect	DDTs (total-calc'd)	110	**11**
			> CSL/ML, Detect	Dibenzofuran	14	**11**

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
			> CSL/ML, Detect	Fluoranthene	16	**11**
			> CSL/ML, Detect	Fluorene	18	**9.6**
			> CSL/ML, Detect	Indeno(1,2,3-cd)pyrene	2.3	**2**
			> CSL/ML, Detect	Mercury	4.6	**3.2**
			> CSL/ML, Detect	PCBs (total calc'd)	25	**3.3**
			> CSL/ML, Detect	Phenanthrene	9.3	**2.6**
			> CSL/ML, Detect	Pyrene	7.7	**6.1**
			> CSL/ML, Detect	Total HPAH (calc'd)	6.8	**4.8**
			> CSL/ML, Detect	Total LPAH (calc'd)	8.5	**3.4**
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.3	0.57
2261	15	46	> CSL/ML, Detect	Acenaphthene	2.8	**1.9**
			> CSL/ML, Detect	Arsenic	1.7	**1**
			> SQS/SL, ≤CSL/ML, Detect	Benzo(a)anthracene	1.2	0.94
			> SQS/SL, ≤CSL/ML, Detect	Benzo(a)pyrene	1.4	0.73
			> SQS/SL, ≤CSL/ML, Detect	Benzo(g,h,i)perylene	1	0.96
			> CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	1.7	**1.5**
			> CSL/ML, Detect	Chrysene	2.3	**1.1**
			> CSL/ML, Detect	DDTs (total-calc'd)	36	**3.6**
			> SQS/SL, ≤CSL/ML, Detect	Dibenzo(a,h)anthracene	1.2	0.52
			> CSL/ML, Detect	Fluoranthene	2.7	**1.8**
			> CSL/ML, Detect	Indeno(1,2,3-cd)pyrene	1.2	**1.1**
			> CSL/ML, Detect	Lead	1.7	**1.4**
			> CSL/ML, Detect	Mercury	2	**1.4**
			> CSL/ML, Detect	PCBs (total calc'd)	14	**1.8**
			> CSL/ML, Detect	Pyrene	6.2	**4.8**
			> CSL/ML, Detect	Total HPAH (calc'd)	2.9	**2.1**
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.6	0.69
	46	76	> CSL/ML, Detect	2,4-Dimethylphenol	48	**48**
			> CSL/ML, Detect	2-Methylnaphthalene	11	**5.1**
			> CSL/ML, Detect	2-Methylphenol	9.8	**9.8**
			> CSL/ML, Detect	4-Methylphenol	3	**3**
			> CSL/ML, Detect	Acenaphthene	15	**10**
			> CSL/ML, Detect	Acenaphthylene	3.9	**3.9**
			> CSL/ML, Detect	Anthracene	18	**3.9**
			> CSL/ML, Detect	Benzo(a)anthracene	15	**13**
			> CSL/ML, Detect	Benzo(a)pyrene	11	**5.7**
			> CSL/ML, Detect	Benzo(g,h,i)perylene	11	**10**
			> CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	9.7	**8.6**
			> CSL/ML, Detect	Chrysene	14	**7.1**
			> CSL/ML, Detect	DDTs (total-calc'd)	230	**23**

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
			> CSL/ML, Detect	Dibenzo(a,h)anthracene	4.2	**1.8**
			> CSL/ML, Detect	Dibenzofuran	18	**14**
			> CSL/ML, Detect	Fluoranthene	32	**22**
			> CSL/ML, Detect	Fluorene	22	**12**
			> CSL/ML, Detect	Indeno(1,2,3-cd)pyrene	7.3	**6.4**
			> CSL/ML, Detect	Mercury	2.4	**1.7**
			> CSL/ML, Detect	Naphthalene	11	**10**
			> CSL/ML, Detect	PCBs (total calc'd)	17	**2.2**
			> CSL/ML, Detect	Phenanthrene	49	**14**
			> SQS/SL, ≤CSL/ML, Detect	Phenol	1.5	0.52
			> CSL/ML, Detect	Pyrene	22	**17**
			> CSL/ML, Detect	Total HPAH (calc'd)	18	**12**
			> CSL/ML, Detect	Total LPAH (calc'd)	27	**11**
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.8	0.76
	76	107	> SQS/SL, ≤CSL/ML, Detect	Anthracene	3.6	0.8
			> CSL/ML, Detect	Benzo(a)anthracene	5.4	**4.4**
			> CSL/ML, Detect	Benzo(a)pyrene	5.1	**2.7**
			> CSL/ML, Detect	Benzo(g,h,i)perylene	4.5	**4.2**
			> CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	4.6	**4.1**
			> CSL/ML, Detect	Chrysene	6.6	**3.3**
			> CSL/ML, Detect	DDTs (total-calc'd)	170	**17**
			> SQS/SL, ≤CSL/ML, Detect	Dibenzo(a,h)anthracene	2.3	0.96
			> CSL/ML, Detect	Fluoranthene	11	**7.6**
			> SQS/SL, ≤CSL/ML, Detect	Fluorene	1.2	0.67
			> CSL/ML, Detect	Indeno(1,2,3-cd)pyrene	5.5	**4.8**
			> CSL/ML, Detect	Mercury	2.5	**1.7**
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.5	0.19
			> CSL/ML, Detect	Phenanthrene	5.2	**1.4**
			> CSL/ML, Detect	Pyrene	9.2	**7.3**
			> CSL/ML, Detect	Total HPAH (calc'd)	7.4	**5.2**
			> CSL/ML, Detect	Total LPAH (calc'd)	2.7	**1.1**
6454	0	30	> CSL/ML, Detect	Cadmium	1.4	**1**
	30	61	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	1.5	0.2
14462	0	30	> CSL/ML, Detect	Acenaphthene	3.2	**2.2**
			> SQS/SL, ≤CSL/ML, Detect	Benzo(a)anthracene	1.1	0.88
			> SQS/SL, ≤CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	1	0.92
			> SQS/SL, ≤CSL/ML, Detect	Chrysene	1.6	0.79
			> CSL/ML, Detect	Fluoranthene	3.1	**2.1**
			> CSL/ML, Detect	PCBs (total calc'd)	26	**3.4**
			> SQS/SL, ≤CSL/ML, Detect	Total HPAH (calc'd)	1.3	0.94

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
14463	0	30	> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	2.6	0.48
	30	61	> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	2.3	**1.4**
			> SQS/SL, ≤CSL/ML, Detect	Butyl benzyl phthalate	1.3	0.1
			> CSL/ML, Detect	Cadmium	2.4	**1.8**
			> SQS/SL, ≤CSL/ML, Detect	Fluoranthene	1.1	0.14
			> CSL/ML, Detect	Mercury	3	**2.1**
			> CSL/ML, Detect	PCBs (total calc'd)	17	**3.1**
			> CSL/ML, Detect	Zinc	4.1	**1.8**
	61	91	> SQS/SL, ≤CSL/ML, Detect	Acenaphthene	3.4	0.96
			> SQS/SL, ≤CSL/ML, Detect	Benzo(a)anthracene	1.2	0.48
			> SQS/SL, ≤CSL/ML, Detect	Chrysene	1.1	0.26
			> SQS/SL, ≤CSL/ML, Detect	Fluoranthene	2.9	0.38
			> SQS/SL, ≤CSL/ML, Detect	Fluorene	2.7	0.8
			> CSL/ML, Detect	Mercury	4.3	**3**
			> SQS/SL, ≤CSL/ML, Detect	Phenanthrene	1.8	0.38
			> SQS/SL, ≤CSL/ML, Detect	Total HPAH (calc'd)	1.7	0.3
			> SQS/SL, ≤CSL/ML, Detect	Total LPAH (calc'd)	1.1	0.52
	91	107	> CSL/ML, Detect	Mercury	3.3	**2.3**
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.5	0.65
14464	0	30	> SQS/SL, ≤CSL/ML, Detect	Mercury	1.2	0.85
			> SQS/SL, ≤CSL/ML, Detect	PCBs (total calc'd)	7	0.91
	30	61	> SQS/SL, ≤CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	1.1	0.56
			> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	2.3	**1.4**
			> SQS/SL, ≤CSL/ML, Detect	Cadmium	1.1	0.85
			> SQS/SL, ≤CSL/ML, Detect	Fluoranthene	1.3	0.17
			> CSL/ML, Detect	Mercury	2.1	**1.4**
			> CSL/ML, Detect	PCBs (total calc'd)	12	**2.2**
			> SQS/SL, ≤CSL/ML, Detect	Total HPAH (calc'd)	1.1	0.21
			> SQS/SL, ≤CSL/ML, Detect	Zinc	1.4	0.59
	61	91	> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	3	**1.8**
			> SQS/SL, ≤CSL/ML, Detect	Butyl benzyl phthalate	1.1	0.083
			> CSL/ML, Detect	Cadmium	18	**14**
			> CSL/ML, Detect	Copper	1.7	**1.7**
			> SQS/SL, ≤CSL/ML, Detect	Fluoranthene	2.4	0.32
			> CSL/ML, Detect	Mercury	4.7	**3.3**
			> CSL/ML, Detect	PCBs (total calc'd)	18	**3.4**
			> CSL/ML, Detect	Silver	1.2	**1.2**
			> SQS/SL, ≤CSL/ML, Detect	Total HPAH (calc'd)	1.3	0.23
			> CSL/ML, Detect	Zinc	39	**17**
	91	107	> SQS/SL, ≤CSL/ML, Detect	Anthracene	2.3	0.5

Historical surface sediment locations and SQS or CSL exceedances, cont.

Location Number	Sample Interval (cm)		Description	Parameter Name	Exceedance Factor (CSL exceedances in bold)	
	Upper	Lower			SQS/SL	CSL/ML
			> CSL/ML, Detect	Benzo(a)anthracene	8.5	**6.9**
			> CSL/ML, Detect	Benzo(a)pyrene	3.8	**2**
			> CSL/ML, Detect	Benzo(g,h,i)perylene	3.4	**3.2**
			> CSL/ML, Detect	Benzofluoranthenes (total-calc'd)	4.7	**4.2**
			> CSL/ML, Detect	Bis(2-ethylhexyl)phthalate	2	**1.4**
			> SQS/SL, ≤CSL/ML, Detect	Butyl benzyl phthalate	3	0.21
			> CSL/ML, Detect	Cadmium	2.2	**1.7**
			> CSL/ML, Detect	Chrysene	7.9	**3.9**
			> CSL/ML, Detect	Copper	1	**1**
			> CSL/ML, Detect	Dibenzo(a,h)anthracene	2.5	**1.1**
			> CSL/ML, Detect	Fluoranthene	12	**8.4**
			> SQS/SL, ≤CSL/ML, Detect	Fluorene	1.4	0.76
			> CSL/ML, Detect	Indeno(1,2,3-cd)pyrene	4.3	**3.8**
			> CSL/ML, Detect	Mercury	5	**3.4**
			> CSL/ML, Detect	PCBs (total calc'd)	68	**8.9**
			> SQS/SL, ≤CSL/ML, Detect	Phenanthrene	2	0.56
			> CSL/ML, Detect	Pyrene	10	**7.9**
			> CSL/ML, Detect	Silver	1	**1**
			> CSL/ML, Detect	Total HPAH (calc'd)	7.9	**5.6**
			> SQS/SL, ≤CSL/ML, Detect	Total LPAH (calc'd)	1.3	0.53
			> CSL/ML, Detect	Zinc	3.9	**1.7**

PCB – polychlorinated biphenyl
PAH – polycyclic aromatic hydrocarbon
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

APPENDIX E
EAST WATERWAY GEOTECHNICAL AND CHEMICAL SUBSURFACE SEDIMENT BORING METHODOLOGY

Prepared for

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November 6, 2009

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1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) Appendix provides sampling and testing procedures for geotechnical and chemistry evaluations in the mound area off the northwest corner of Terminal 25 in the East Waterway (the mound). This Appendix was prepared as requested by the Port of Seattle and U.S. Environmental Protection Agency (EPA) as part of the East Waterway Supplemental Remedial Investigation/Feasibility Study (SRI/FS) and supports the Subsurface Sediment Sampling QAPP prepared by Windward Environmental, LLC (Windward).

2 PROJECT MANAGEMENT

The overall management structure is consistent with that presented in the QAPP, including key personnel and responsibilities. Additional personnel for the mound investigation are described in this Section. The Environmental Protection Agency (EPA) and East Waterway Group (EWG) will be involved in all aspects of this project, including discussion, review, and approval of the QAPP and the interpretation of the results of the investigation.

2.1 Project Organization and Team Member Responsibilities

The sampling effort for the mound field investigation will be led by Anchor QEA, LLC (Anchor QEA); however, all other aspects of the sampling effort will be led by Windward, as described in the QAPP.

2.1.1 Project Management

The EPA and EWG project managers for the mound investigation are the same individuals identified in the QAPP.

2.1.2 Field Coordination

In addition to the personnel presented in Section 2.1.2 of the QAPP, an engineering geologist will lead collection of borings from the mound. Wes MacDonald will collect borings and log sediment acquired for geotechnical testing. Mr. MacDonald can be reached as follows:

Mr. Wes MacDonald
Anchor QEA, LLC
1423 Third Avenue, Suite 300
Seattle, WA 98101
Telephone: 206-287-9130
Cellular phone: 206-450-8946
E-mail: wmacdonald@anchorqea.com

Sediment collected for chemical testing will be processed and logged by the same individuals identified in the QAPP. Thai Do (Windward) will ensure that appropriate protocols for sample preservation and holding times are observed, and will oversee delivery of environmental samples to the designated laboratories for chemical analysis. Leslie McKee (Anchor QEA) will coordinate processing and logging of sediment samples from the borings.

2.1.3 Quality Assurance/Quality Control

Personnel identified for quality assurance/quality control are the same individuals identified in the QAPP.

2.1.4 Laboratory Project Management

Analytical Resources, Inc. (ARI) will perform chemical and geotechnical analyses for the mound investigation. Sue Dunnihoo will serve as the laboratory project manager for ARI and will be responsible for completing project management tasks identified in Section 2.1.4 of the QAPP.

2.1.5 Data Management

Personnel identified for quality assurance/quality control are the same individuals identified in the QAPP.

2.2 Problem Definition/Background

The mound investigation is intended to supplement existing geotechnical and chemistry data for subsurface sediments in the area of the mound. This Appendix identifies sampling locations and testing to be conducted on samples from the mound.

The mound is located at the southern entrance to Slip 27 and was the former location of a rail barge loading facility. Current water depths range from approximately -30 feet mean lower low water (MLLW) at the federal channel boundary to -51 feet MLLW in the area 60 feet west of the federal channel boundary. The area around the mound was dredged in 2005 as part of the Phase 1 Removal Action. The mound was not dredged during that event due to uncertainty of mound geotechnical and chemical characteristics. Existing slopes on the mound range from 3 horizontal to 1 vertical (3H:1V) along the boundary of the Phase 1 removal area to 7H:1V or flatter further up the slope towards Terminal 25.

The nature and extent of potential contamination in the mound area will be addressed as part of the SRI through additional chemical testing. In addition, if active remediation is necessary in the mound, the presence of soft (weak) strata may pose significant challenges to feasibility of remedial options due to potential instability of dredge slopes and/or an engineered cap. Additional geotechnical explorations are necessary to better delineate the extent of soft sediments in the area of the mound.

2.2.1 Mound Geology

Figure 1 provides locations of borings that have been advanced in the vicinity of the mound during previous studies. The closest explorations, BH-2 and BH-1, were drilled in 1990 by Hong West Associates (Hong West). The Hong West explorations, shown in Cross Section A-A' on Figure 2, indicate relatively deep soft deposits of silt and organic silt, with some near-surface silty sand in the vicinity of the mound. Borings BH-1 and BH-2 were advanced to depths ranging from 68.5 to 83 feet below the mudline.

In addition to the Hong West explorations, Boring DH-8 was drilled in 1970 by Neil Twelker & Associates in the vicinity of the mound. However, a log from this exploration was not available at the time this Appendix was developed. Anchor QEA will continue to research the location of this log and associated data as part of the geotechnical evaluation.

Additional studies have been performed more recently to characterize chemistry of near-surface sediments in the vicinity of the mound (Windward 2002; SAIC 1999). These explorations, which were performed using vibracore methods, provide limited useful geotechnical data for the evaluations that are necessary to design a remedial solution for the mound, if necessary. Most importantly, the vibracore does not provide in situ relative density information that may be obtained using the standard penetration test. Section 3 of this Appendix describes methodology for subsurface borings using a barge-mounted drill rig.

2.2.2 Mound Subsurface Sediment Chemistry

The chemical characteristics of mound sediments have not been tested. As samples are collected for geotechnical characterization, sub-sampling for chemical testing will also occur. Additional details of chemical sampling and testing are included in Section 3.

2.3 Project/Task Description and Schedule

The sampling of mound subsurface sediment will be initiated following EPA's approval of the QAPP. The mound investigation will be conducted after other subsurface sediment sampling presented in the QAPP is completed.

Two separate field crews will work simultaneously; one crew will collect sediment borings and a second crew will log and process the sediment boring samples immediately following collection. Sediment samples taken from the borings will be submitted to ARI for chemical analyses (see Section 3.1.3). Chemical analyses of the samples, as described in Section 3.4 of the QAPP, are expected to be completed 3 weeks after samples have been collected. Preliminary, unvalidated data will be evaluated by EWG and EPA to select archived samples for additional analyses, as described in Section 3.1.3. Validated data are expected to be received approximately 5 weeks after chemical analyses are complete. A draft report presenting the chemical data will be submitted to EPA 8 weeks after validated data are received. Because other subsurface core collection, sampling, and analysis will occur prior to the mound investigation (using the vibracorer and MudMole™), the draft chemical data report of the mound investigation is anticipated to be provided as an addendum to the main subsurface data report.

2.4 Data Quality Objectives and Criteria

The Data Quality Objective (DQO) and criteria for the mound investigation are the same as those identified in Section 2.4 of the QAPP.

2.5 Special Training/Certification

Special training/certification requirements for the mound investigation are the same as those identified in Section 2.5 of the QAPP.

2.6 Documentation and Records

Documentation and records needed for field observations and laboratory analyses are the same as those presented in Section 2.6 of the QAPP.

3 DATA GENERATION AND ACQUISITION

This section describes the collection and handling of sediment samples for geotechnical and chemical analyses. Elements include sampling design, sampling methods, sample handling and custody requirements, analytical methods, quality assurance/quality control (QA/QC), and other protocols.

3.1 Sampling Design

This section describes the sampling design for the boring exploration program in the mound.

3.1.1 Sampling Locations

The proposed exploration program in the mound consists of advancing two borings from a barge-mounted drill rig to a depth of 50 to 60 feet below the existing mudline. Borings are proposed to be located as shown in Figures 1 and 2. Borings will be performed by a subcontract driller who will be selected at the time of work based on availability. Qualified drillers with barge experience that will be considered include Boart Longyear, Cascade, Gregory Drilling, and Holocene Drilling. Borings will be advanced using a drill rig stationed on a barge anchored with spuds or other appropriate methods. Sediment samples will be collected using a standard split spoon for geotechnical index testing and Shelby tubes for geotechnical consolidation, strength, bulk density, and chemical testing.

3.1.2 Sectioning of Borings

Chemical and geotechnical index samples will be collected from alternating intervals for each boring as shown in Figure 3. Chemical samples will be collected using a 30-inch Shelby tube to collect 24-inch-long (2-foot) sample intervals. Two types of geotechnical samples will be collected. For geotechnical index testing, samples will be collected from 18-inch (1.5-foot) intervals using a split spoon sampler. For undisturbed geotechnical testing, a 30-inch Shelby tube will be used to collect 24-inch-long (2-foot) sample intervals. However, the upper-most sample may not be an intact sample due to disturbance associated with initial penetration of the auger into the sediment. Chemical samples will be collected down to just below the native sediment contact. Geotechnical index test samples will be collected at 5-foot intervals below the native sediment contact to the planned bottom of the hole.

Undisturbed geotechnical test samples will be collected from select intervals based on field observations by the engineering geologist. At least one undisturbed geotechnical sample will be collected from native material.

3.1.3 Chemical and Geotechnical Analysis

The top three intervals sampled for chemical testing using Shelby tubes from each of the mound borings will be analyzed for Sediment Management Standards (SMS) chemicals (semivolatile organic compounds [SVOCs], polychlorinated biphenyl [PCB] Aroclors, mercury, and other metals) using analytical methods presented in Section 3.4 of the QAPP. Each of these three samples will also be analyzed for total organic carbon (TOC), total solids, and grain size. Each sediment interval collected for chemical testing will include archived sediment for potential testing of tributyltin (TBT), organochlorine pesticides, and dioxin/furans. Sample intervals located below the top three intervals sampled for chemical testing will be archived for potential testing of SMS chemicals, TOC, total solids, grain size, TBT, organochlorine pesticides, and dioxin/furans. At least one interval for chemical testing will be archived within native sediment.

Geotechnical index testing will be collected from intervals shown in Figure 3 using a split spoon sampler. These intervals are alternating with intervals collected for chemical testing. Geotechnical index testing will consist of water content, specific gravity, Atterberg limits, and grain size, but each test may not be completed from every interval. Geotechnical index testing will be conducted according to methods presented in Section 3.4 of this Appendix.

Geotechnical strength testing (consolidated undrained [CU] triaxial strength testing, consolidation, and bulk density) will be performed according to standard ASTM procedures (see Section 3.4) on relatively undisturbed samples collected using Shelby tubes. The selection of actual index test and Shelby tube samples for geotechnical characterization will be determined in the field by a qualified geotechnical engineer; however a potential scenario for testing is presented in Figure 3. Strength, consolidation, and bulk density samples are anticipated at one per surface interval to assess in situ capping and one per major soil type per boring to assess slope stability, for an estimated two to four consolidation tests, two to four CU triaxial tests, and four to eight bulk density tests.

3.2 Sampling Methods

3.2.1 Sample Identification

Each subsurface sediment core sampling location will be assigned a unique alphanumeric location ID number. The first four characters of the location ID are "EW" to identify the EW project area, followed by "09" to identify the year in which the sample was collected (i.e., EW09). The next four characters are "SB" to indicate the type of samples to be collected (soil boring), followed by a consecutive number identifying the specific location within the EW (e.g., SB01).

The sample ID will consist of the location ID followed by a numerical suffix that indicates which depth horizon the sediment sample came from. For example, the sample from the upper 2-foot section of the core collected from the mound at location EW09-SB01 will be identified as EW09-SB01-0-2; the 2- to 3.5-foot section of sediment from the same core will be identified as EW09-SB01-2-3.5; and so on.

Rinsate blanks, as described in the QAPP, will be assigned the first four characters of the location ID, followed by "SB" and "RB" (i.e., EW09-SB-RB). The next character will be a consecutive number beginning with "1." For example, the first rinsate blank sample collected would be identified as EW-09-SB-RB1.

3.2.2 Location Positioning

Location positioning will be conducted as identified in Section 3.2.2 of the QAPP.

3.2.3 Collection of Borings

Samples collected from borings on the mound will be collected at regular intervals from the mudline downward using two methods. Geotechnical index test samples will be collected using a split spoon sampler so that Standard Penetration Test (SPT) blowcounts can be recorded. Geotechnical strength, consolidation, bulk density, and chemistry samples will be obtained using stainless steel, thin wall Shelby tubes because an undisturbed sample is required for these particular geotechnical tests, and a larger core is needed to obtain sufficient sample size for chemical analyses.

The Shelby tube and split spoon sampler will be used in an alternating sequence for each boring as shown in Figure 3. The drill rig will be used to advance a casing (hollow steel pipe or hollow-stem auger) to the top of the sample interval. For chemistry samples, the drill rig will hydraulically push a decontaminated 3-inch diameter Shelby tube below the casing to collect a 24-inch sample. Where split spoons are used, the SPT will be initiated, which uses a calibrated hammer system to advance the 1.5-inch (inner diameter) sampler a total of 18 inches below the casing to collect the sample.

The borings will be collected by an engineering geologist from Anchor QEA. The following data will be recorded on the core collection log:

- Sampling location, time, tide, and depth of water to sediment (as measured by leadline)
- Elevation of location as measured from MLLW
- Location coordinates from DGPS
- Names of field personnel collecting and handling the cores
- Observations made during core collection, including weather conditions, complications, ship traffic, and other details associated with the sampling effort
- Physical description of the sampler (e.g., intact, bent)
- Length and depth intervals of each section
- Standard penetration blow counts over the 18-inch drive, in 6-inch intervals
- Sample recovery, depicted graphically on the log
- Any deviation from the approved QAPP

3.2.4 Boring Processing

3.2.4.1 Split Spoon Samples

Split spoon samples will be opened on the barge and logged by the engineering geologist. The following observations will be noted on the field log for each split spoon sample:

- SPT blowcounts over the 18-inch drive, in 6-inch intervals
- Sample recovery, depicted graphically on the log

- Density/stiffness based on blow count
- Physical soil description in accordance with ASTM procedures (ASTM D 2488 and ASTM D 2487 – Unified Soil Classification System) including soil type, density/consistency of soil, and color
- Odor (e.g., hydrogen sulfide, petroleum)
- Visual stratification, structure, and texture
- Vegetation and debris (e.g., woodchips or fibers, paint chips, concrete, sand blast grit, metal debris
- Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
- Presence of oil sheen

Once these notes have been made, the sample will be removed from the split spoon sampler and placed into sample containers. The sample containers will be labeled with the sample identification number, packed in a cooler, and shipped to ARI under chain of custody for geotechnical testing.

3.2.4.2 Shelby Tube Samples

Shelby tubes will be transported and processed at ARI as soon as possible after they are received. All Shelby tubes from the boring will be logged according to the same protocols described in Section 3.2.4 of the QAPP. The same processing team identified in the QAPP will log and sample sediment from Shelby tube samples for consistency.

Select Shelby tube samples will be collected only for chemistry testing, however, based on field observations, one or more Shelby tube samples from each mound boring will also be tested for geotechnical testing using undisturbed Shelby tube samples. Shelby tube intervals requiring chemical and undisturbed geotechnical testing will be refrigerated if not processed within four hours of collection. First, sediment in the Shelby tube will be extracted for geotechnical testing by ARI staff following protocols in Section 3.4. Only the minimum sediment necessary for the pertinent undisturbed geotechnical test (CU triaxial strength, consolidation, or bulk density) will be extracted. The remaining sediment unused for undisturbed geotechnical testing will be collected by the Windward/Anchor QEA processing team for chemistry testing following extraction of the sediment for geotechnical testing.

Remaining sediment for chemical testing will be handled and processed according to Section 3.2.4 of the QAPP. Following homogenization, the Windward/Anchor QEA processing team will place sediment in appropriate sample containers for sample analysis, as described in Section 3.3.1 of the QAPP. Sediment from Shelby tubes will be extracted by the geotechnical laboratory within adequate timeframes to meet chemical and geotechnical sample hold times, as specified in Sections 3.4 of the QAPP and Section 3.4 of this Appendix.

Intervals extracted for geotechnical and chemical testing will be noted on processing logs and in sample names (Section 3.2.1). For example, if only 1 foot of the Shelby tube interval is extracted for undisturbed geotechnical testing, the other foot of remaining sediment will be used for chemical testing, with the processing log and sample name describing the specific one foot interval used for chemical testing.

3.2.5 Field Sampling and Processing Equipment

Section 3.2.5 of the QAPP provides a list of items needed in the field for collecting borings and sample processing.

3.2.6 Decontamination Procedures

All sediment processing and homogenizing equipment used during sample processing at the laboratory will be decontaminated using the same procedures as described in Section 3.2.6 of the QAPP.

3.2.7 Field Generated Waste

Field generated waste, including soil cuttings, will be placed into a 55-gallon drum on board the drill barge. Filled drums will be sent by the drilling subcontractor for offsite disposal as part of their contract. Excess sediment remaining after processing of the Shelby-tubes at ARI will be placed in drums and disposed in an appropriate manner using the procedures outlined in ARI's Chemical Hygiene Plan. Drums will be properly labeled, kept closed, and stored separately from other incompatible wastes (e.g., liquid solvents). Windward will ensure that all drums are properly transported and disposed of.

3.3 Sample Handling and Custody Requirements

3.3.1 Sample Handling Procedures

3.3.1.1 Geotechnical Testing

Sediment samples for geotechnical index testing (water content, specific gravity, Atterberg limits, and grain size) will be placed in appropriately sized, pre-cleaned, labeled, wide-mouth jars according to Table 1. Geotechnical strength, consolidation, and bulk density test samples will be retained within their respective Shelby tubes until ready for processing at the geotechnical laboratory (Table 1). Extraction of the sample for geotechnical testing will be completed using decontaminated utensils to allow for remaining sediment to be processed as described in Section 3.2.4.2 for chemical testing. Because remaining sediment may be limited, sample jars for SMS chemistry will be prioritized, with additional sample jars filled as volume permits. The most efficient combination of jars will be determined in consultation with ARI in order to maximize remaining sediment for chemical testing.

Table 1
Sample Containers and Laboratories Conducting Analyses

Parameter	Container	Laboratory
Water content	4-oz glass or plastic jar	ARI
Specific gravity	8-oz glass or plastic jar	ARI
Atterberg limits	8-oz glass or plastic jar	ARI
Grain size	16-oz glass or plastic jar	ARI
Bulk density	3-inch diameter Shelby tube	ARI
Consolidated undrained (CU) triaxial testing	3-inch diameter Shelby tube	ARI
Consolidation testing	3-inch diameter Shelby tube	ARI

ARI – Analytical Resources, Inc.

3.3.1.2 Chemical Testing

Sediment samples for chemical testing will be placed in appropriately sized, pre-cleaned, labeled, wide-mouth glass jars and capped with Teflon®-lined lids, as described in Section 3.3.1 of the QAPP.

3.3.2 Sample Custody Procedures

Sample chain of custody procedures will be in accordance with the procedures described in Section 3.3.2 of the QAPP.

3.3.3 Shipping Requirements

Sample shipping procedures will be in accordance with the procedures described in Section 3.3.3 of the QAPP.

3.4 Analytical Methods

Chemical analytical methods will be in accordance with procedures described in Section 3.4 of the QAPP. Analytical methods and sample handling requirements for geotechnical samples are presented in Table 2. No additional data quality indicators are required for geotechnical testing beyond that presented in Section 3.4 of the QAPP.

Table 2
Laboratory Analytical Methods and Sample Handling Requirements for Geotechnical Testing

Parameter	Method	Reference	Sample Holding Time[a]	Preservative
Water content	Drying oven	ASTM D2216	6 months	Cool/3-30 °C
Specific gravity	Pycnometer	ASTM D854	None	None
Atterberg limits	Sieve	ASTM D4318	None	None
Grain size[b]	Sieve/pipette	PSEP (1986)	6 months	Cool/0-6 °C
Bulk density	Volumetric/gravimetric	ASTM D2937	None	None
Consolidated undrained (CU) triaxial testing	Triaxial testing apparatus	ASTM D4767	None	None
Consolidation testing	Consolidometer	ASTM D2435	None	None

a Any archive samples will be frozen at the laboratory until the Windward or Anchor QEA PM authorizes their disposal.

b Grain size intervals include gravel: fractional % phi >-1 (>2000 microns); sand: fractional % phi -1-0 (1000-2000 microns), fractional % phi 0-1 (500-1000 microns), fractional % phi 1-2 (250-500 microns), fractional % phi 2-3 (125-250 microns), fractional % phi 3-4 (62.5-125 microns); silt: fractional % phi 4-5 (31.2-62.5 microns), fractional % phi 5-6 (15.6-31.2 microns), fractional % phi 6-7 (7.8-15.6 microns), fractional % phi 7-8 (3.9-7.8 microns); clay: fractional % phi 8-9 (1.95-3.9 microns), fractional % phi 9-10 (0.98-1.95 microns), fractional % phi 10+ (<0.98 micron)

3.5 Quality Assurance

Quality assurance/quality control procedures will be in accordance with Section 3.5 of the QAPP. No additional quality assurance/quality control procedures are required for geotechnical testing beyond that presented in Section 3.5 of the QAPP.

3.6 Other Protocols

Unless specified in this Appendix, other protocols associated with subsurface sediment sampling on the mound will be conducted in compliance with procedures defined in the QAPP. This includes instrument/equipment testing, inspection, maintenance, calibration, and frequency, inspection/acceptance of supplies and consumables, data management, assessment and oversight, and data validation and usability.

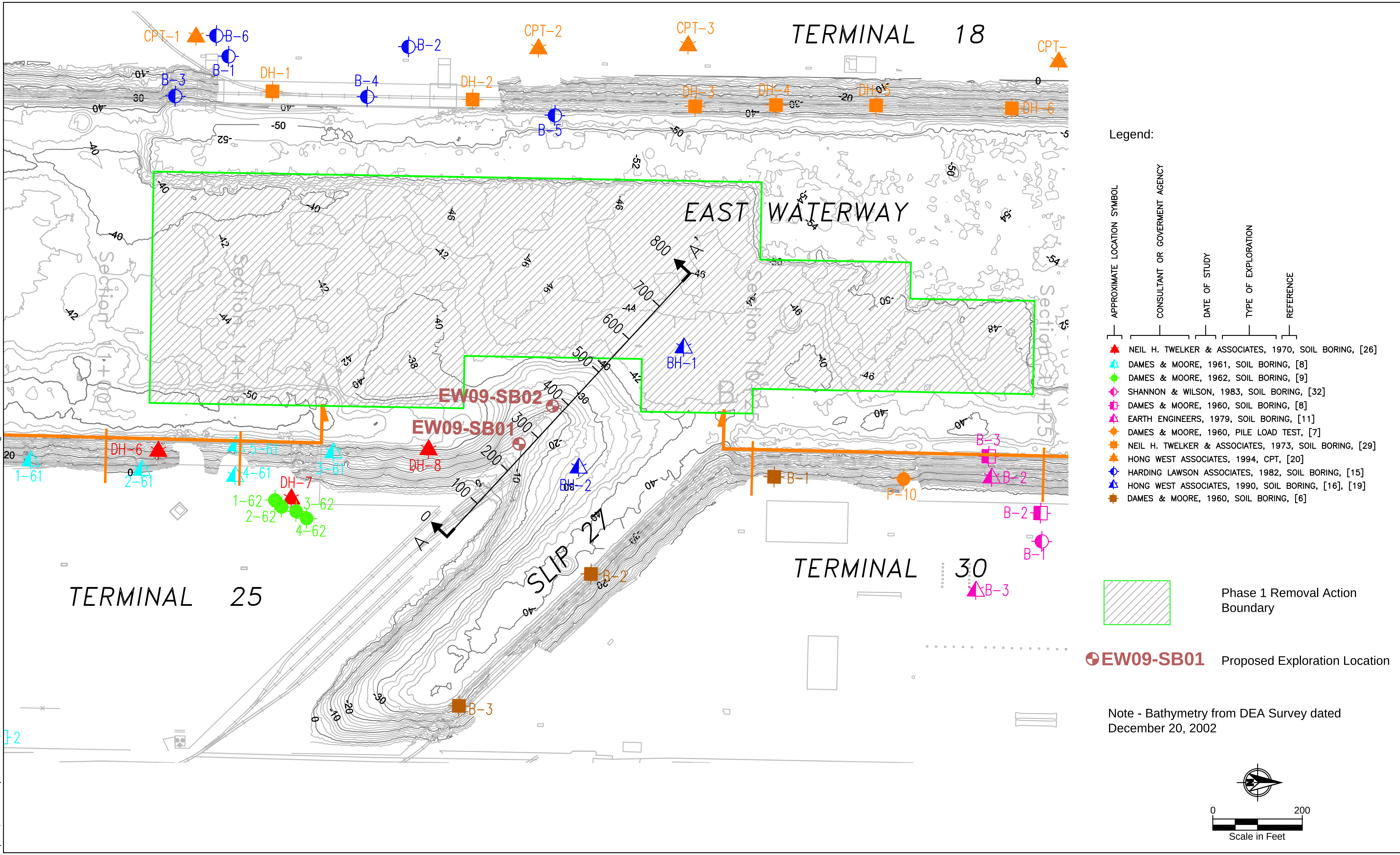
4 REFERENCES

PSEP. 1986. Recommended protocols for measuring conventional sediment variables in Puget Sound. Prepared for the Puget Sound Estuary Program. U.S. Environmental Protection Agency, Region 10, Seattle, WA.

SAIC. 1999. East Waterway channel deepening sediment characterization, Duwamish Waterway, Seattle, Washington. Prepared for the U.S. Army Corps of Engineers, Seattle District. Science Applications International Corporation, Bothell, WA.

Windward. 2002. East Waterway, Harbor Island superfund site: Nature and extent of contamination. Subsurface sediment data report – Phase 3. Prepared for the Port of Seattle. Windward Environmental, LLC, Seattle, WA.

FIGURES

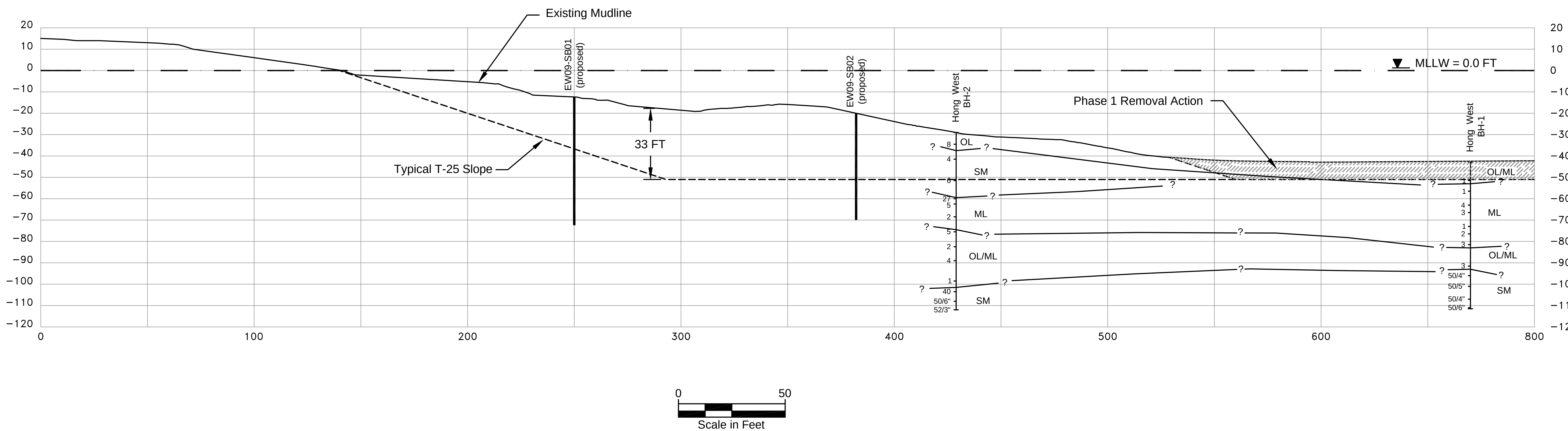


K:\Jobs\060003-PORT OF SEATTLE\060003-01\06000301-RP-001.dwg FIG 1

Apr 08, 2009 1:30pm cdavidson

ANCHOR QEA

Figure 1
Existing and Proposed Exploration Location, Terminal 25 Mound Area
East Waterway Subsurface Sediment Boring Methodolgy
East Waterway SRI/FS



Legend:

OL Organic SILT
SM Silty SAND
ML SILT

Figure 2
Cross Section A-A', Terminal 25 Mound Area
East Waterway Subsurface Sediment Boring Methodolgy
East Waterway SRI/FS

Apr 08, 2009 1:29pm cdavidson K:\Jobs\060003-PORT OF SEATTLE\060003-01\06000301-RP-002.dwg FIG 2

Figure 3
Mound Geotechnical and Chemistry Sampling Scheme

Chemical Sampling (Shelby Tube)[1,6]	Geotechnical Index Testing (Split Spoon)[2]	Chemistry	Undisturbed Geotechnical Testing[2]			Geotechnical Index Testing			
			CU Triaxial Strength	Consolidation	Bulk Density	Water Content	Atterberg Limits[3,4]	Grain Size[3,4]	Specific Gravity[3,5]
EW09-SB01-0-2.0		X		X	X				
	EW09-SB01-2.-3.5					X	X	X	X
EW09-SB01-3.5-5.5		X	X						
	EW09-SB01-5.5-7					X	X	X	X
EW09-SB01-7-9		X							
	EW09-SB01-9-10.5					X		X	
EW09-SB01-10.5-12.5		X (A)		X	X				
	EW09-SB01-12.5-14					X	X		
EW09-SB01-14-16		X (A)	X						
	EW09-SB01-16-17.5					X		X	X
EW09-SB01-17.5-19.5		X (A)							
	EW09-SB01-19.5-21					X	X		
	EW09-SB01-24.5-26					X			
EW09-SB01-26-28			X	X	X	X	X	X	X
	EW09-SB01-29.5-31					X			

Depth Below Mudline (ft)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Notes:

1. Chemical samples collected down to just below native alluvium contact. Top three intervals will be analyzed for chemistry. All intervals collected for chemical testing below the top three intervals will be archived (A). Boring continues with split spoon sampling at 5-foot intervals below native alluvium contact until planned
2. One or more Shelby tube samples will be divided into subsamples for geotechnical and chemical samples. In these samples, an intact portion of the Shelby tube will be tested for consolidated undrained triaxial testing, consolidation, and/or bulk density. The remainder of sediment from the Shelby tube will be collected for chemical analysis.
3. Atterberg Limits, Grain Size, and Specific Gravity test intervals to be selected in the field based on engineering geologist interpretation of soils.
4. A total of 5 to 10 Atterberg Limits and 5 to 10 Grain Size Tests planned per boring
5. A total of approximately 4 or 5 Specific Gravity Tests planned per boring

APPENDIX F
REVIEW OF DEPTH TO NATIVE SEDIMENT IN THE EAST WATERWAY

Prepared for

Port of Seattle

Prepared by

Anchor QEA, LLC
1423 Third Avenue, Suite 300
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November 6, 2009

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Attachments

Attachment A Historic Core Logs

1 INTRODUCTION

This appendix supports the Subsurface Sediment Sampling Quality Assurance Project Plan (QAPP). It provides a summary of depth of native sediment in the East Waterway (EW) using available information from previously collected sediment cores. The objective of this report is to verify that proposed subsurface core sampling described in the QAPP is of sufficient depth to collect native sediment. The data reviewed included historical sediment core logs, dredge records, and EW bathymetry. The data presented in this report include a summary of native sediment characteristics and estimated depths to native sediment using the best available data.

2 NATIVE SEDIMENT CHARACTERISTICS

This section presents an overview of sediment characteristics of the EW. Sediment characteristics were evaluated from key historical sediment core logs from the following reports:

- EVS and Hart Crowser, 1996. *Harbor Island Supplementary Remedial Investigation.*
- SAIC, 1999. *East Waterway Channel Deepening Sediment Characterization.*
- Windward, 2002. *East Waterway Phase 3 Subsurface Sediment Data Report.*
- Anchor, 2006. *Sediment Characterization Report, Port of Seattle Terminal 30.*
- Windward and RETEC, 2006. *Lower Duwamish Waterway Remedial Investigation Data Report: Subsurface Sediment Sampling for Chemical Analyses.*

Sediment stratigraphy of the Lower Duwamish Waterway (LDW) is expected to be similar to that of the EW. Extensive study of the LDW was conducted by Windward and RETEC (2006), which included 56 cores from River Mile (RM) 0 (southern end of the EW) to RM 4.9. Sediments were grouped into three stratigraphic units identified for the LDW based primarily on density, color, sediment type, texture, and marker bed horizons. These strata were identified in the report as described below:

- Recent Silt – Unconsolidated organic silt. This material was characterized by higher moisture content, finer texture, and higher visible organic matter compared to the underlying materials.
- Upper Alluvium/Transition – This middle unit consisted of mostly silty sand. The

upper alluvium material was characterized by low organic matter, higher density, and higher percentage of sand compared to the upper unit. Some organic silt and woody layers were often present.

- Lower (Native) Alluvium – This lower unit was predominantly sand (95 percent and non-silty) with gradational sequences of sand and silty sand layers. The lower alluvium unit was typically demarcated by a sharp horizon at its upper interface.

While the LDW study was not conducted in the EW, the native sediment stratigraphy in the EW would be similar based on common geologic histories. Three core logs from the LDW study near Harbor Island (RM 0.0 to RM 0.1) and other historical logs within the EW (i.e., EVS and Hart Crowser 1996; SAIC 1999; Windward 2002; and Anchor 2006) were reviewed. Based on density, color, and sediment type as described in these studies, the sediments of the EW can be loosely grouped as follows:

- **Recent Silt –** Same as described above in the LDW.
- **Upper Alluvium/Fill –** Variable. Gravelly, silty sand, or sandy silt. Trace to occasional wood, organics, and shells.
- **Lower (Native) Alluvium –** Dominated by silty sand or sand interbedded with silt (seams and layers). Sand is fine to medium with occasional clay pockets and seams. Trace to moderate wood (twigs, non-anthropogenic) and shells. Less of a sharp demarcation exists between the Upper Alluvium/Fill and Lower Alluvium than was identified in the LDW stratigraphy.

3 ESTIMATED DEPTHS OF NATIVE ALLUVIUM

This section presents the native alluvium lithologic and stratigraphic characteristics, estimated depth below mudline, and associated elevations from available core information. This overview is based on selected historical sediment core logs, as listed above and contained in Attachment A. Table 1 summarizes the estimated depths to the top of native alluvium for each historic core log. Figures 1a and 1b depict historical coring locations along with corresponding estimated depths to the top of native alluvium, the proposed subsurface sediment sampling locations described in the QAPP, and previous dredge events. Note that these depths represent the mudline at the time of the study and may have been altered by subsequent dredge events. A summary of dredge events is provided in Section 4.

3.1 EVS and Hart Crowser, 1996

Three cores were collected within the EW channel between approximately Stations 1400 and 5300 (Figures 1a and 1b). The length of the core tubes was 12 feet, and between 8 and 9 feet of recovery were achieved using vibracore methodology. Native alluvium was encountered in two of the three cores at approximately 5 feet below mudline, which is equivalent to -44.5 to -50.5 mean lower low water (MLLW) in this area. Note that native sediment was not tagged in the remaining core due to insufficient depth. Recovered native alluvium beds were approximately 2 to 4 feet thick. Native alluvium was characterized as medium dense, thinly bedded, silty fine sand.

Dredge events that would impact these depth estimates include the Stage 1 (-51 feet MLLW) and Phase 1 (-51 feet MLLW plus a 1 foot sand cap) dredging. Due to these dredge events, the depths to native alluvium are expected to be shallower than indicated.

3.2 SAIC, 1999

Approximately 70 cores were collected throughout the EW between Stations 0 and 5800 (including Slip 36) for a channel deepening study. Of the 70 core logs, representative cores were selected throughout the area of the EW sampled for this assessment. Coring was completed using three different lengths of core tubes (8, 12, and 16 feet) by vibracore methodology. Core recoveries averaged around 92 percent, with a few cores requiring multiple attempts to achieve sufficient recovery. Native alluvium depths and elevations varied depending on location within the EW. In general, the native alluvium was encountered between 4 and 10.8 feet below mudline, which is equivalent to between -40 and -54 feet MLLW. Recovered native alluvium beds varied in thickness between 2 and 6 feet. Native alluvium was characterized as medium dense to dense, gray/black, silty, fine to medium sand.

Due to the spatial extent of sampling, the majority of the depth estimates were affected by several dredge events. A summary of these events is provided in Section 4. In general, depths to native alluvium are expected to be shallower than indicated.

3.3 Windward, 2002

Twelve cores were reviewed from the Phase 3 subsurface sediment characterization report. Cores were collected in the EW between Stations 1700 and 5800. Core tube lengths varied between 8 and 17 feet, with an average core recovery of 82 percent using Mudmole® methodology. Native alluvium depths ranged from 2 to 14 feet below mudline, which is equivalent to between -45 and -55 feet MLLW. Recovered native alluvium beds varied in thickness from 2 to 8 feet. Native alluvium was characterized as dark grey to grey brown, fine to medium sand with about 10 percent silt and occasional silt seams and interbeds.

Dredge events that would impact these depth estimates include the Phase 1 (-51 feet MLLW plus a 1 foot sand cover) and the T-30 (-51 feet MLLW) dredges. Due to these events, the depths to native alluvium is expected to be shallower than indicated.

3.4 Anchor, 2006

Twenty cores were collected in the vicinity of Terminal 30 between Stations 2000 and 3600 for a sediment characterization report. The length of the core tubes was 14 feet, with 12 feet of recovery typically achieved. The majority of the cores were only logged to 6 feet below mudline. Native alluvium sediment was identified between 2 and 4 feet below mudline, which is equivalent to -43 to -48 feet MLLW in this area. However, differentiation of upper alluvium from native alluvium was less apparent in these cores than in other areas of the waterway, possibly due to previous dredging activities. Native alluvium was characterized as gray/black, silty, fine to medium sand with clay and silt interbeds.

Dredge events that would impact these depth estimates include the Terminal-30 (-51 feet MLLW) dredge boundary and the subsequent dredge event along Terminal 30 to -55 feet MLLW before being backfilled with riprap.

4 DREDGING HISTORY

Portions of the EW have been dredged multiple times since its original construction in the early 1900s. A detailed summary of recent dredging and fill activities conducted in the EW over the past 10 years is included in the Existing Information Summary Report (Anchor and Windward 2007). Dredging in the EW has been conducted to maintain and deepen existing berths and to deepen the federal navigation channel to its authorized depth of -51 feet MLLW. Figures 1a and 1b show recent dredging events from December 1999 to November 2009.

A summary of the recent dredge events in the EW is listed below (Figures 1a and 1b):

- Stage 1 navigational dredging (December 1999 to February 2000) to -51 feet MLLW from the north end of the EW to Station 4950.
- Terminal 30 berth dredging (2002) to -44 feet MLLW.
- Phase 1 dredging (January 2004 to February 2005) to -51 feet MLLW. A sand layer was placed over most of the dredge footprint at -52 feet MLLW.
- Slip 36 dredging (August 2004 to February 2005) to -40 feet MLLW.
- Terminal 46 maintenance dredging (2005) to -51 feet MLLW.
- Terminal 30 berth deepening (January 2008 to February 2009) to -51 feet MLLW.
- Terminal 18 dredging in Berths 2 through 5 (January 2005 to November 2006) to -51 to -52 feet MLLW.
- Terminal 18 minor maintenance dredging (January and February 2009) to -51 feet MLLW (less than 1,000 cubic yards removed; too small to be shown on Figures 1a and 1b).

Dredging in the EW conducted prior to 1990 was not indicated on Figures 1a and 1b because the records of these dredging events are limited and exact dimensions are unknown. These dredging events are described below:

- Terminal 25 (1970s) to -50 feet MLLW up to the federal channel boundary.
- Terminal 25 (1981) to -55 feet MLLW from Stations 4250 to 6100. This event included dredging a keyway along the face of Berth 25 for construction of the under pier slope. The keyway was backfilled with riprap to approximately –50 feet MLLW. The outer edge of the excavation would likely have been less than 25 feet from the face of the pier. The keyway width was 5 feet and the outer edge sloped from –55 feet MLLW (toe of keyway) to approximately -45 feet MLLW.
- Terminal 30 (1980s) to -55 feet MLLW from Stations 1600 to 3600 before being backfilled with riprap. This dredging was similar to the Terminal 25 keyway dredging described above.

5 SUMMARY OF DEPTH TO NATIVE ALLUVIUM FINDINGS

Core logs from five studies were reviewed along with dredge depths and bathymetry data in order to determine the depth to native alluvium in the EW. Results of the review indicated that native alluvium depths ranged from approximately 4 to 14 feet below mudline at the time the studies were conducted. Subsequent dredge events likely affected these depths to native sediment. Based on this assessment, required core tube lengths will vary depending on location. The final elevation of surface sediments following recent dredge events in the EW is thought to be at or within several feet of native alluvium. Therefore, core depths required in these dredged areas are expected to require shorter tubes (on the order of 8 to 12 feet). As summarized in Figures 1a and 1b, cores completed outside the federal navigation channel along Terminal 18, Terminal 25, and within Slip 36 will require shorter tubes (8 to 12 feet). Cores completed south of Station 4950 (coincident with the southern end of the Phase 1 dredging) will require longer tubes (12 to 14 feet). Two additional deep borings will be collected and analyzed for geotechnical purposes to 50 to 60 feet below mudline. These borings are described in detail in Appendix E.

6 LIMITATIONS

The limitations of assessing depths of stratigraphic units from historical logs include accuracy of water depth, tides, mudline calculations, recorded elevations, and quality of sediment lithology descriptions. Core logs and associated lengths to each stratigraphic unit were not corrected when the length recovered was less than the length driven. However, percent recoveries were generally high, which would not substantially change the results of the analysis. The interpretations of the depths to native alluvium presented in this appendix may be affected by these limitations and should be considered a preliminary assessment.

7 REFERENCES

Anchor. 2006. Sediment characterization report, Port of Seattle Terminal 30. Prepared for the Port of Seattle. Anchor Environmental, LLC, Seattle, WA.

Anchor and Windward. 2008. Existing Information Summary Report (EISR), East Waterway Operable Unit, Supplemental Remedial Investigation and Feasibility Study.

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SAIC. 1999. East Waterway channel deepening sediment characterization, Duwamish Waterway, Seattle, Washington. Prepared for the U.S. Army Corps of Engineers, Seattle District. Science Applications International Corporation, Bothell, WA.

Windward. 2002. East Waterway, Harbor Island superfund site: Nature and extent of contamination. Subsurface sediment data report- phase 3. Prepared for the Port of Seattle. Windward Environmental, LLC, Seattle, WA.

Windward and RETEC. 2006. Lower Duwamish Waterway remedial investigation data report: subsurface sediment sampling for chemical analyses. Prepared for the Lower Duwamish Waterway Group. Windward Environmental, LLC, and The RETEC Group, Seattle, WA.

TABLES

Table 1
Review of East Waterway Historic Core Logs For Depth to Native Alluvium

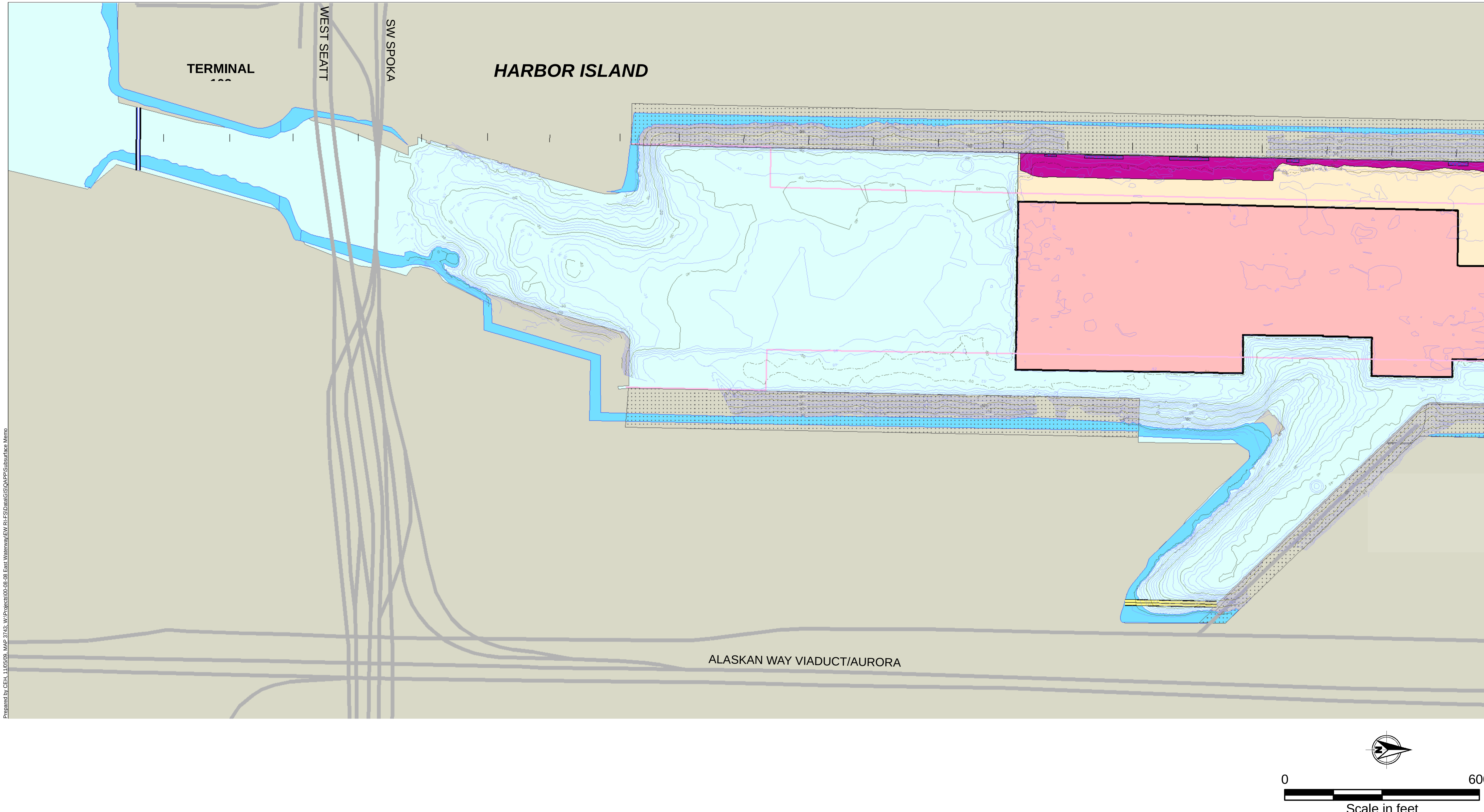
Study/Core Log[1]		Mudline (ft MLLW)[2]	Elevation (ft MLLW)	Depth to Top of Native Alluvium (ft)	Notes
EVS and Hart Crowser, 1996					
HI-	EW-01	-41.5	-45.8	4.3	--
HI-	EW-06	-48	none	none	Depth to native is greater than 8.9 feet
HI-	EW-11	-45.5	-51.5	6	--
SAIC, 1999					
ED-	1	-40.8	-44.8	4	--
ED-	4	-37.3	-40.7	3.4	--
ED-	8	-39.5	-47.5	8	--
ED-	10	-38.8	-47.6	8.8	--
ED-	12	-43.5	-53.9	10.4	--
ED-	13	-37.3	-46.5	9.2	--
ED-	14	-42.8	-52.6	9.8	--
ED-	17	-43.8	-52.4	8.6	--
ED-	21	-43.1	-53.6	10.5	--
ED-	23	-41.1	-46.9	5.8	--
ED-	30	-38.1	-46.2	8.1	mudline/coordinates from core 2, depths and native sediment evaluation from core 1
ED-	34	-45.5	-52.7	7.2	--
ED-	36	-34.9	-45.7	10.8	--
ED-	38	-42.1	-50.1	8	--
ED-	39	-40.3	-50.4	10.1	--
ED-	40	-42.6	-52.6	10	--
ED-	41	-41	-45	4	--
ED-	43	-40.5	-42.8	2.3	--
ED-	44	-43.4	-47.4	4	--
ED-	45	-37.1	-41.6	4.5	--
ED-	46	-47.1	-49.9	2.8	--
ED-	48	-47.6	none	none	core 4, short core only 5 feet of recovery, depth to native is greater than 5 feet
ED-	50	-44	-52.2	8.2	--
ED-	53	-44.6	-52.5	7.9	--
ED-	54	-44.7	-50.7	6	--
ED-	58	-41.2	-42.7	1.5	--
ED-	62	-37.4	-45.4	8	--
ED-	63	-38.9	-47.1	8.2	--
ED-	70	-38.7	-49.8	11.1	--
ED-	75	-41.8	-47.9	6.1	core 1
ED-	75	-42.6	-51.6	9	core 2
CG-	1	-37.2	-40.5	3.3	core 1
CG-	2	-34.9	-40	5.1	core 2
CG-	3	-31.9	-36.1	4.2	core 1
CG-	4	-32.5	-37.3	4.8	core 1
CG-	5	-34.9	-39.7	4.8	core 1

Table 1
Review of East Waterway Historic Core Logs For Depth to Native Alluvium

Study/Core Log[1]		Mudline (ft MLLW)[2]	Elevation (ft MLLW)	Depth to Top of Native Alluvium (ft)	Notes
Windward, 2002					
EW-	143	-40.7	-47.2	6.5	--
EW-	144	-36.5	-50.5	14	--
EW-	145	-43.3	-55.3	12	--
EW-	146	-41	-55	14	--
EW-	147	-38.1	-48.1	10	--
EW-	148	-41.1	-49.1	8	--
EW-	149	-43.4	-51.4	8	--
EW-	150	-44.2	-55.2	11	--
EW-	151	-44	-51	7	--
EW-	152	-42	-51	9	--
EW-	153	-40.4	-45.4	5	--
EW-	154	-49.4	-51.4	2	
Anchor, 2006					
T-30	S1-01A	-41.7	-43.7	2	--
T-30	S1-01B	-40.4	-44.2	3.8	--
T-30	S1-02	-40.3	-43.6	3.3	--
T-30	S1-03	-41.3	-43.5	2.2	--
T-30	S3-02	-47.1	-48.6	1.5	--
T-30	S4-01	-46.8	-47.3	0.5	--
T-30	S5-01	-45.5	-47.5	2	--

Notes:
1. Data included on the table are from available core logs with the most appropriate spatial representation.
2. Mudline depths were measured at the time the study was conducted and may not reflect current depths due to dredge events and recent deposition.

FIGURES



- Proposed sampling location

Historical Subsurface Sample Location by Event with Depth to Lower Alluvium (ft)[a]

- EVS & Hart Crowser, 1996
- SAIC, 1999
- Windward, 2002
- Anchor, 2006

Location ID: CG-1
Depth to lower alluvium: 3.3

- Terminal 18 maintenance dredging (completed 2009, -51 MLLW)
- Terminal 18 dredging, Berths 2 through 5 (completed 2006, -51 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 navigational dredging (completed 2000, -51 MLLW)
- Intertidal zone
- Dock/Pier
- Slip 27 Bridge
- Road
- Navigation channel
- East Waterway Study Area Boundary

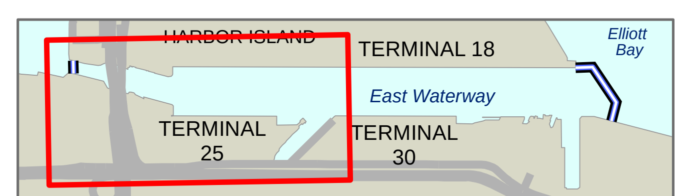
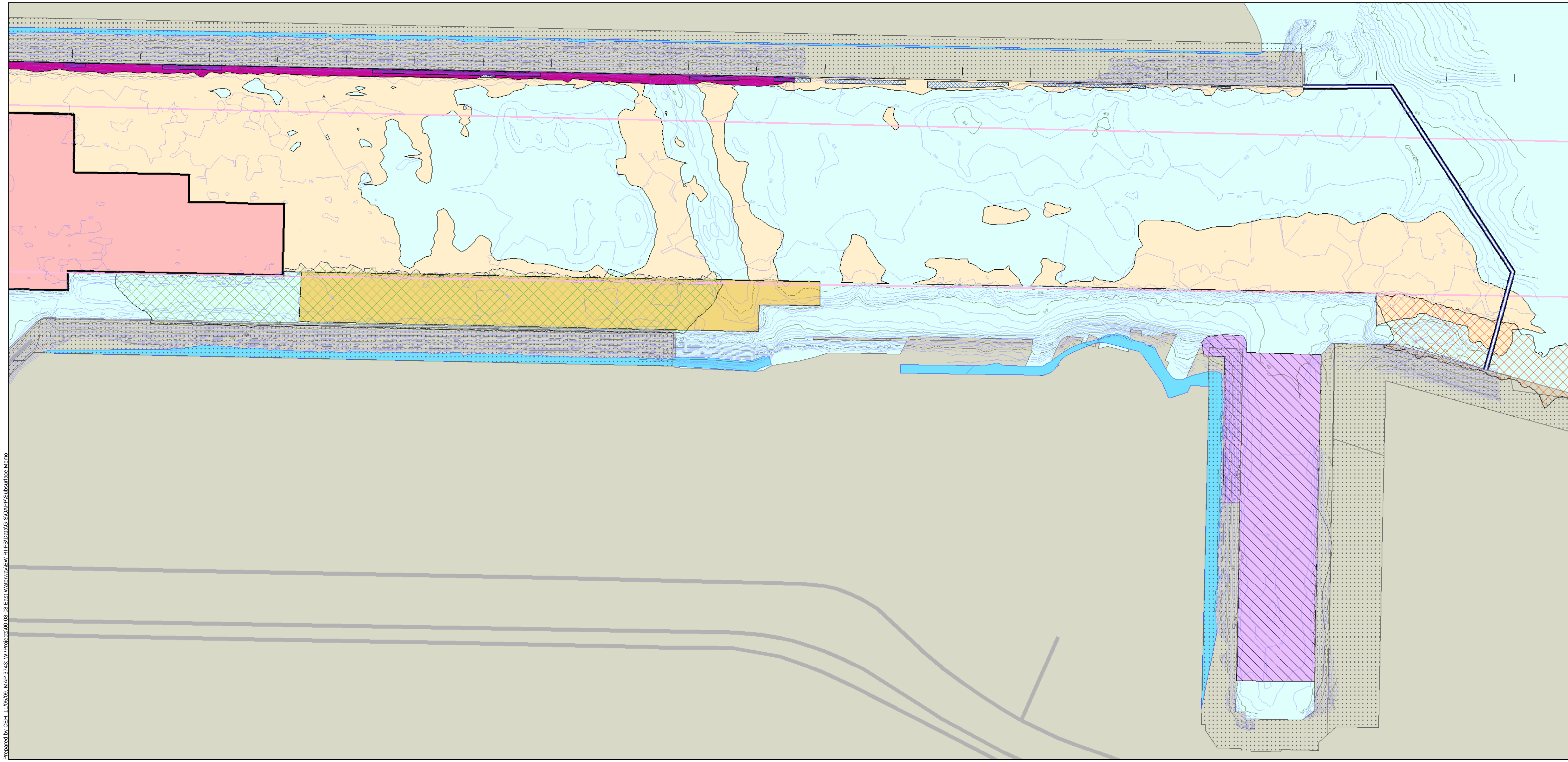


Figure 1a
Estimated Depth to Top of Lower Alluvium (in feet) from Mudline - South
Subsurface Sediment QAPP
East Waterway Study Area

[a] When lower alluvium was not encountered, depth are preceded with ">". For cores located in dredged areas, depth to lower alluvium for each core represents pre-dredge conditions. Lower alluvium elevations in the dredged areas is thought to be at or within several feet of the post-dredge surface.

Prepared by CEH, 11/05/09, MAP 3743; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Subsurface Memo



Prepared by CEH, 11/05/09, MAP 3743; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Subsurface Memo

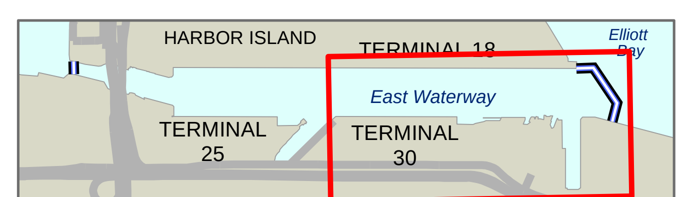
- Proposed sampling location

Historical Subsurface Sample Location by Event with Depth to Lower Alluvium (ft)[a]

- EVS & Hart Crowser, 1996
- SAIC, 1999
- Windward, 2002
- Anchor, 2006
- Intertidal zone
- Dock/Pier
- Road
- Navigation channel
- East Waterway Study Area Boundary

Location ID
CG-1
3.3
Depth to lower alluvium

- Terminal 18 maintenance dredging (completed 2009, -51 MLLW)
- Terminal 30 maintenance dredging (completed 2009, -51 MLLW)
- Terminal 18 dredging, Berths 2 through 5 (completed 2006, -51 MLLW)
- Terminal 46 maintenance dredging (completed 2005, -51 MLLW)
- Slip 36 dredging (completed 2005, -40 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 navigational dredging (completed 2000, -51 MLLW)
- Terminal 30 berth dredging (completed 2002, -44 MLLW)



0 600
Scale in feet

Figure 1b
Estimated Depth to Top of Lower Alluvium (in feet) from Mudline - North
Subsurface Sediment QAPP
East Waterway Study Area

[a] When lower alluvium was not encountered, depth are preceded with ">". For cores located in dredged areas, depth to lower alluvium for each core represents pre-dredge conditions. Lower alluvium elevations in the dredged areas is thought to be at or within several feet of the post-dredge surface.

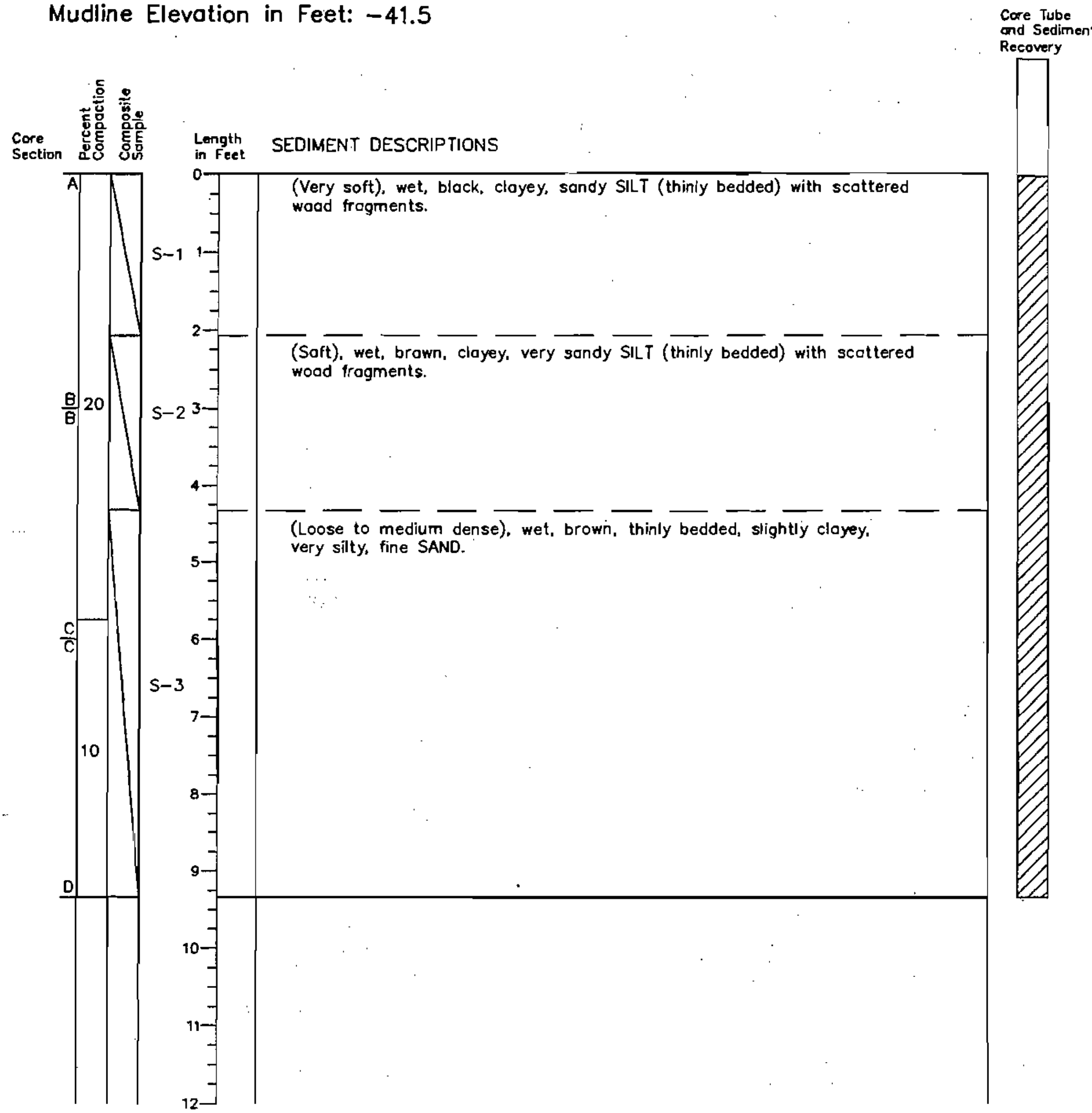
ATTACHMENT A – SELECTED HISTORIC CORE LOGS

EVS AND HART CROWSER, 1996

Sediment Core Log HI-EW-01

Type of Sample: Impact Core
Date/Time: 3/20/95 09:15
Recovery Length in Feet: 9.3
Mudline Elevation in Feet: −41.5

Northing: 213,969
Easting: 1,267,447
Drive Length in Feet: 11.0



Note:
1. Horizontal control is based on NAD 83 datum (DGPS) and vertical control is based on MLLW datum.
2. Length of core tubes is 12 feet.
3. Collocated surface samples were collected with van Veen grab samplers.
4. This station was located on a bathymetric slope resulting in difficult sediment recovery.

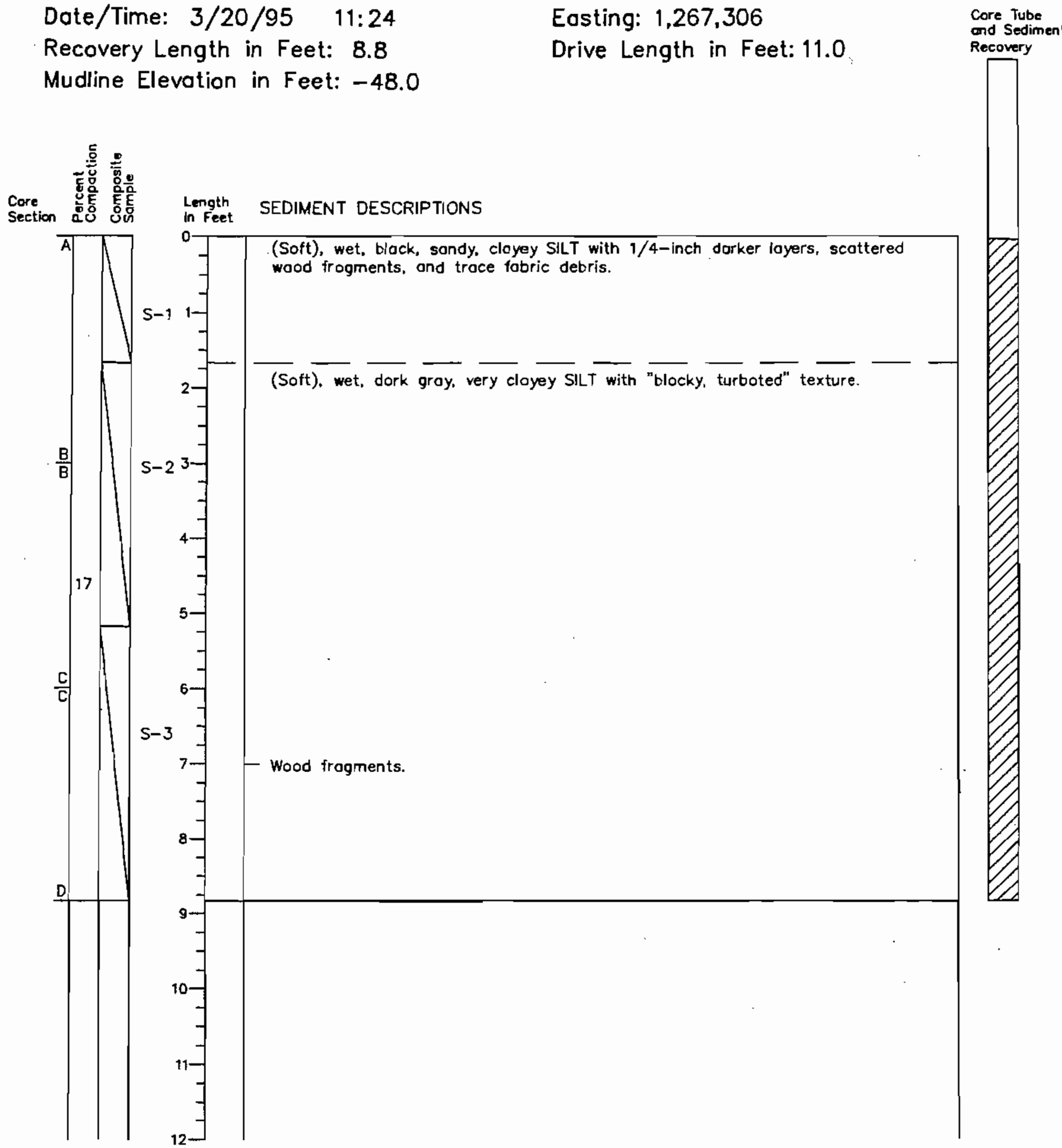
HARTCROWSER
J-4249-04 6/95
Figure E-2

cvd 6/13/95 1=1 hc-pcp
HIEW01

Sediment Core Log HI-EW-06

Type of Sample: Impact Core
Date/Time: 3/20/95 11:24
Recovery Length in Feet: 8.8
Mudline Elevation in Feet: −48.0

Northing: 215,410
Easting: 1,267,306
Drive Length in Feet: 11.0



Note: 1. Horizontal control is based on NAD 83 datum (DGPS) and vertical control is based on MLLW datum.
2. Length of core tubes is 12 feet.
3. Collocated surface samples were collected with van Veen grab samplers.

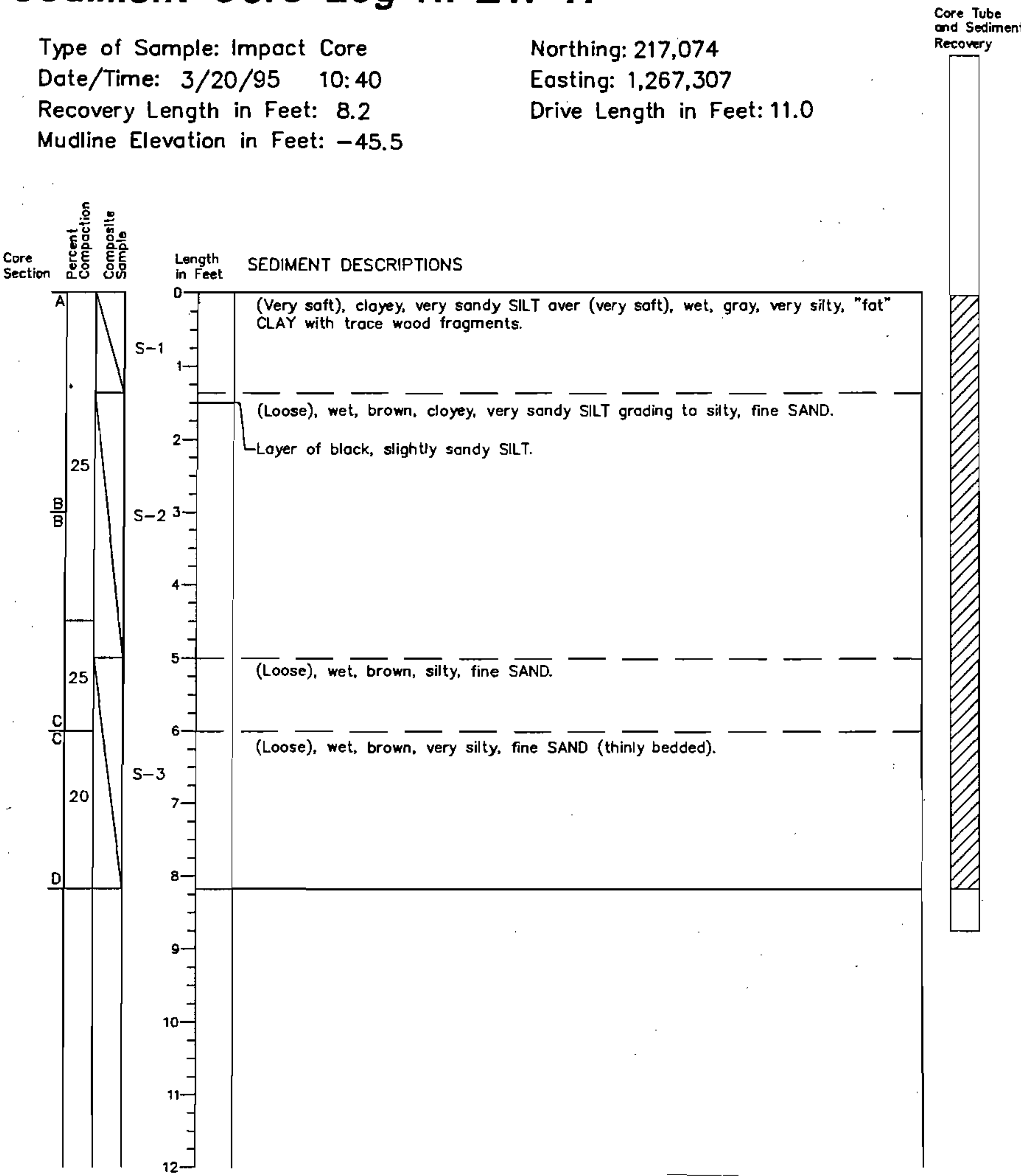
cvd 6/13/95 1=1 hc-pcp
HIEW06

HARTCROWSER
J-4249-04 6/95
Figure E-3

Sediment Core Log HI-EW-11

Type of Sample: Impact Core
Date/Time: 3/20/95 10:40
Recovery Length in Feet: 8.2
Mudline Elevation in Feet: −45.5

Northing: 217,074
Easting: 1,267,307
Drive Length in Feet: 11.0



Note: 1. Horizontal control is based on NAD 83 datum (DGPS) and vertical control is based on MLLW datum.
2. Length of core tubes is 12 feet.
3. Collocated surface samples were collected with von Veen grab samplers.

HARTCROWSER
J-4249-04 6/95
Figure E-4

cvd 6/13/95 1=1 hc-pcp
HIEW11

SAIC, 1999

SAIC

SEDIMENT CORING LOG (page 1)

Core Number ED-1 (core 1)

DATE SAMPLED:	6/18/98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.4 - 0.2 = 12.2
TIME:	0817	% RECOVERY:	99%
UNCORRECTED DEPTH (-FT):	41.2	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	-0.5	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 29.560
ACOE WATER LEVEL (TIDE):	+0.4	LONGITUDE:	122 20 44.146
WATER DEPTH ACOE MLLW:	40.8	NORTHING:	213365.57
VESSEL:	R/V Nancy Anne	EASTING:	1267161.65
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Overcast 55°F, calm winds N <5 Knots

18" = 1.5 * Cut off nose - 0.2'

13.9 - 1.5 = 12.4

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980100 comp. w/ ED-1 (#2)			ML CL		(0 to 1.0 ft): Dark gray SILT and CLAY with trace vf sand, soft, wet. Reddish worm in top inch.
1					ML		1.0 — (1.0 to 2.5 ft): Sandy SILT, with little gravel (up to 2.5 inches), with mussel, etc. shells, with a little hair. Very dark gray. wet, soft.
2							
2.5					SP-SM		2.5 — (2.5 to 7.8 ft): SAND with little silt; sand is fine mostly (a little vf), trace gravel (up to 0.6 inch), some plant debris and probable hair debris. Dark gray, Mod. dense.
3							
4		980101	4.0				(4.0) (At 4.0+ ft depth was metal plug + clay? pipe)
					SP-SM		Same as above. Silt occurs as distinct layers with common clam shells (thin, 1" long, white)
5							
6							

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DIV0440\EASTWATERWAYCORELOG.DSF 7/24/98

SEDIMENT CORING LOG (page 2)

Core Number ED-1 (core 1)

DATE SAMPLED:	8-18-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.2
TIME:	0817	% RECOVERY:	99%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
6		980101			SP-SM		SAND (see above)	
7								
8					ML		7.8 SILT, clean, dark brown-gray. Very firm, moist.	
					SP		8.4 Fine SAND, clean, with white clam shells (Macoma?). Mod. dense, trace fine gravel.	
9					ML		9.0 SILT, clean (no sand), Brown-gray, stiff, moist.	
10					SM		10.0 (10.0-12.2 ft): Fine SAND, with some silt (15-20%) in discrete layers. Some shells and locally common plant/wood debris. Dark brown-gray. Dense.	
11		980238 "Z"	11.1					
12			12.1				12.2 (Bottom of core)	

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SEDIMENT CORING LOG

Core Number ED-1 (core 2)

DATE SAMPLED:	8/17/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.0 - 0.2 = 4.8
TIME:	1216	% RECOVERY:	83%
UNCORRECTED DEPTH (-FT):	49.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	6.6	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 29.590
ACOE WATER LEVEL (TIDE):	7.5	LONGITUDE:	122 20 44.158
WATER DEPTH ACOE MLLW:	41.5	NORTHING:	213368.63
VESSEL:	R/V Nancy Anne	EASTING:	1266160.88
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Overcast, calm, 60-65F winds light S <2 knots

18" = 1.5' ~~Need 33' cut to 4.0~~ * Just cut off nose -0.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1		980100 (comp. w/ ED-1 #1)			ML/CL		(0 to 1.2 ft): SILT and CLAY, with trace vf sand, very dark gray, soft, wet, with live 4" long tube worm and small orange worms (latter is in top inch) (spiochaetopterid worm)
1–2					ML		1.2 — (1.2 to 2.1 ft): Sandy SILT, with little gravel (up to 1.5 inches, rounded), sand is vf-fine, some plant debris and trace hair, very dark gray, soft to firm, wet
2–3					SP-SM		2.1 — Fine SAND, with little silt, which occurs in layers of silty sand or sandy silt, (a little vf sand also); mod. dense, dark gray. (2.1 to 4.8 ft)
3–4		980101	3.3 / 3.8				~~(3.3)~~
4–5		Did not Sample					(4.8) — (Bottom of core)
5–6							Note: due to insufficient sample volume, this sample in this core was extended about ½ foot deeper to about 3.8 ft.

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SEDIMENT CORING LOG (page 1)

Core Number ED-4 (core 1)

DATE SAMPLED:	8/17/98	CORE PENETRATION:	16
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	13.7 − 0.2 = 13.5
TIME:	1352	% RECOVERY:	86%
UNCORRECTED DEPTH (-FT):	475	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+9.3	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 32.383
ACOE WATER LEVEL (TIDE):	+10.2	LONGITUDE:	122 20 44.155
WATER DEPTH ACOE MLLW:	37.3	NORTHING:	213651.56
VESSEL:	R/V Nancy Anne	EASTING:	1267166.65
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Overcast, 65°F, calm winds light < 2 knots, S sun breaks.

50" = 4.2
17.9 − 4.2 = 13.7

*Cut off nose −0.2'

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980098 (comp. w/ ED-4 #2)			ML		(0–0.6 ft): SILT with some vf sand, ~~soft~~ ~~v.~~ dark gray, wet.
0.6					SM		−0.6 (gradational) (0.6–1.2 ft): vf–fine SAND with some silt. Loose, wet. Dark gray.
1.2					ML		−1.2 (sharp contact) (1.2–3.4 ft): SILT, with little vf–fine sand, Sand occurs in discrete layers and grades into silt. Firm to v. firm. With common wood/plant debris (one up to 1" x 2" long). Dark brown-gray.
3.4		↓	3.4				(3.4) (sharp)
3.4		980097 (comp. w/ ED-3 #1)			SP		(3.4–6.2 ft): Dark gray ~~SILT~~ TP SAND w/ trace ~~little~~ silt (~5%). Mostly fine sand, some very fine, and a little ~~of~~ TO med to coarse sand.
6		↓			SP		

12.6
13.5

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SEDIMENT CORING LOG (page 2)

Core Number ED-4 (core 1)

DATE SAMPLED:	8-17-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	13.5
TIME:	1352	% RECOVERY:	86 %
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980097 (Comp. w/ ED-3#1)			SP		-6.2 SAND (See above)
							Sandy SILT ~~with~~, Sand is vf-fn, SILT is light chocolate brown, sand is dark gray. Interbedded. Stiff. Dense, (6.2-6.9 ft)
1 7							-6.9 (6.9-8.0 ft): Very fine to fine SAND, with
					SP-SM		little silt. Pretty clean sand, dark gray. Dense to v. dense.
2 8							-8.0 (gradational)
					SM		(8.0-13.5 ft): Silty SAND, vf-fine, Interbedded/laminated and intermixed Sand/Silt. Has more sand than silt in lower half of interval, but about equal amounts in upper half.
3 9							
4 10							
5 11							
					SM		
6 12							

SAIC

SEDIMENT CORING LOG (page 3)

Core Number ED-4 (core 1)

DATE SAMPLED:	8-17-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	13.5
TIME:	1352	% RECOVERY:	86 %
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
12		980097					Silty SAND (see above)	
		980237 "Z"	12.6		SM			
13								
			13.5				13.5 (Bottom of core)	
14								
3								
4								
5								
6								

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SEDIMENT CORING LOG

Core Number ED-4 (core 2)

DATE SAMPLED:	8/17/98	CORE PENETRATION:	7.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	6.0
TIME:	1113	% RECOVERY:	85%
UNCORRECTED DEPTH (-FT):	45.5	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	4.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 32.931
ACOE WATER LEVEL (TIDE):	4.9	LONGITUDE:	122 20 44.189
WATER DEPTH ACOE MLLW:	40.6	NORTHING:	213656.47
VESSEL:	R/V Nancy Anne	EASTING:	1267164.41
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Mostly cloudy, sun breaks 60-65°F winds light S.

6" = 0.5
6.5 - .5 = 6.0

** Cut to 4.0', but only need 3.4'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980098 (comp. w/ ED-4 #1)			ML/CL		(0 to 1.5 ft): Dark gray SILT and CLAY, with little vf sand, soft, wet
1							
1.5							1.5 — (gradational) —
2					ML/SP		(1.5 to 4.0 ft): SILT and SAND, in subequal amounts (~55% silt), sand is vf-fn, well-laminated and interbedded silt/sand, also intermixed. Very firm, mod. dense. Minor amounts of brown shells + plant wood debris. Dark brownish gray.
3							
3.7		Not Sampled	~3.7				(core measures out to a clean 3.7 ft)
4							(4.0) (Bottom of core)
5							
6							

SEDIMENT CORING LOG (page 1)

Core Number ED-8 (core 1)

DATE SAMPLED:	8/12/98	CORE PENETRATION:	16.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	16.6 − 0.2 = 16.4
TIME:	1347	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	42.5	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+2.1	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 36.557
ACOE WATER LEVEL (TIDE):	+3.0	LONGITUDE:	122 20 44.221
WATER DEPTH ACOE MLLW:	39.5	NORTHING:	214074.50
VESSEL:	R/V Nancy Anne	EASTING:	1267170.44
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Clear, Sunny 75°F winds N <5 knots

16" = 1.3
17.9 − 1.3 = 16.6

* Cut off nose −0.2
* Surface was disturbed by piston, (top 2-4 cm)

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980081 (Comp w/ ED-8#2)			ML/CL		(0 to 4.2 ft): SILT and CLAY, very dark gray grading down to dark gray, with a little trash (hair + refuse) and plant and wood debris, Soft, grading down to almost firm. wet to very moist, clay decreases with depth.
1							
2							
3							
4			4.0				(4.0)
							4.2
					ML		SILT with some very fine to fine Sand, with plant debris and trash fairly common, Dark gray, Laminated, Very firm. Very moist.
5							
6							

12.5
13.5

SEDIMENT CORING LOG

Core Number ED-8 (core 1) (page 2)

DATE SAMPLED:	8-12-98	CORE PENETRATION:	16.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	16.4
TIME:	1347	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980083 (comp. w/ ED-7 #1)			ML		SILT, with some fine-vf Sand (as above)
7							
8							(8.0) — (gradational transition) —
					ML / SP		SILT and SAND, in about equal amounts, interbedded and very laminated. Sand is vf-fine. Very firm, dense. Moist. Dark brown gray, ~~some~~ trace plant debris.
9							
10							
11							
12							(12.0) — — —

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SEDIMENT CORING LOG (page 3)

Core Number ED-8 (core 1)

DATE SAMPLED:	8-12-98	CORE PENETRATION:	16.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	16.4
TIME:		% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
12		980083			ML		12.0 (Gradational contact)
			12.5				(12.0–16.4 ft): SILT with some (~20%) sand; sand is vf-fine. Laminated. Dark brown-gray, moist. Stiff. trace plant fibers.
		~~98005~~ TO 980226					
1 13		"Z"					
		Not Sampled	13.5				
2 14							
3 15							
4 16					ML		16.4 (Bottom of Core)
5 17							
6							

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12.5 & 13.5

SEDIMENT CORING LOG

Core Number ED-8 (core 2)

DATE SAMPLED:	8/12/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	6.0
TIME:	1230	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	44.2	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	4.1	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 36.435
ACOE WATER LEVEL (TIDE):	5.0	LONGITUDE:	122 20 44.232
WATER DEPTH ACOE MLLW:	39.2	NORTHING:	214062.15
VESSEL:	R/V Nancy Anne	EASTING:	1267169.44
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear 70-75°F wind, W/NW 5 knots.

6" + 0.5
6.5 - 0.5 = 6.0 * Cut down to 4.2'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980081 (Comp w/ ED-8 #1)			ML		(0 to 2.7 ft): SILT with some clay and trace vf to fine sand, Some trash (hair) debris and plant material. Very dark gray, wet. H_2S odor (H_2S = zero). Soft. Shells near base. (HNu = zero)
1							
2							
2.7					ML/SP		(2.7 – 4.0 ft): Dark brown-gray Sandy SILT (almost equal amounts of sand + silt). Sand is vf - fine. Laminated, interbedded. With trash (hair) and plant debris. Weak H_2S odor. Firm. Wet.
3							
4			4.0				(4.0) (Bottom of described core)
5							
6							

REVIEWED BY: ______

PAGE 1 OF 1

SEDIMENT CORING LOG (page 1)

Core Number ED-10 (core 1)

DATE SAMPLED:	8/10/98	CORE PENETRATION:	16.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	14.1 - 0.2 = 13.9
TIME:	1419	% RECOVERY:	85%
UNCORRECTED DEPTH (-FT):	39.9	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+0.2	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 31.326
ACOE WATER LEVEL (TIDE):	+1.1	LONGITUDE:	122 20 42.310
WATER DEPTH ACOE MLLW:	38.8	NORTHING:	213542.00
VESSEL:	R/V Nancy Anne	EASTING:	1267291.02
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Wind 10 knots N 75°F Sunny P.C.

46" 3.8' Cut core nose - 0.2'

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980062				ML/CL	SILT: with little clay and trace v. fine SAND, sticky moderate plasticity, very moist to wet. ~~ugre~~ soft v. dark gray to black slight odor
1						1.1 ML/CL	1.1 SILT with little to some clay and trace very fine SAND soft to firm, sticky moderate to high plasticity. v.d. gray to black moderate H_2S odor 2ppm when opened. moist to wet.
2						2.0 SM	SAND: fine with some silt and trace clay? grayish brown very moist to wet moderate to poorly sorted. trace plant debris and wood debris 5ppm ~~intact~~ PID when open.
3						2.9 ML/CL	SILT: with clay trace f. sand, trace rootlets, moderate to high plasticity, v. moist, olive brown-gray. Soft to firm.
		980064				3.2 ML	3.2 grades into interbedded (laminated layers) of v. fine ~~silt~~ SAND and ~~sand~~ SILT with little to some hair and rootlets gray brown, moist and
4						4.0 ML	firm. (3.2 to 4') 5ppm PID, sheen on wet surface
						4.4 SM ML	AS ABOVE 4.4' Interbeds of v. fine SAND with SILT (silty sand and SILT with some SAND) (very poorly sorted) lots of woody debris (twigs 2-3" long) & flat wood, d. gray brwn., loose, very moist
5							
6							

SEDIMENT CORING LOG (page 2)

Core Number ED-10 (core 1)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY	OBSERVATIONS
		980064				SM/ML		
							SAME AS ABOVE	
7								
8								
							8.4 END OF CORE RUN	
						SM/ML	8.8 SAME AS ABOVE	
9					SP-SM		SAND; very fine to fine with little silt w/ trace rootlets. homogenous ~~t~~exture, ~~brownish~~ grayish brown, moist dense to very dense. moderate to well sorted.	
10								
11								
		archive						
12		980216						

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PAGE 2 OF 3

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SEDIMENT CORING LOG (page 3)
Core Number ED-10 (1)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE		
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
		980216			SP-SM		
		archive 2					SAME AS ABOVE
12		Not Sampled					
							12.4 (bottom of core)
13							
14							
4							
5							
6							

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SEDIMENT CORING LOG

Core Number ED-10 Core 2

DATE SAMPLED:	8/10/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	6.2 - 0.2 = 6.0
TIME:	1112	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	-40.9	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+2.2	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 31.205
ACOE WATER LEVEL (TIDE):	+3.1	LONGITUDE:	122 21 42.257
WATER DEPTH ACOE MLLW:	37.8	NORTHING:	213529.67
VESSEL:	R/V Nancy Anne	EASTING:	1267294.42
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Weather P.C. sunny, 65-70°F winds W/SW 5 knots

4" 6.5 - 0.3 * Cut off nose -0.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.2		9800062				ML	SILT: with little to trace v. fine sand; v. dark gray to black very soft and wet, strong H_2S odor, 30ppm when core was opened.
1.2–2.0						ML/CL	SILT: with little clay and trace v. fine sand and trace rootlets. soft to firm. moderate plasticity olive gray brown. somewhat sticky.
2.0–2.6						ML/CL	SILT: with some clay and trace fine sand and trace rootlets strong H_2S odor, very moist high plasticity very sticky
2.6–2.9						SM	SAND, fine to med. with some silt and some woody and plant debris, loose and wet slight odor
2.9–3.9						ML	SILT: uniform and homogeneous with a little v. fine sand. gray to gray brown. firm & moist slight H_2S odor
3.9							(Bottom of core)

Depth scale: 1, 2, 3, 4, 5, 6

SEDIMENT CORING LOG (page 1) (core #1)

Core Number ED-12 (long)

DATE SAMPLED:	8/3/98	CORE PENETRATION:	12.75
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.4 - 0.2 = 12.2
TIME:	1213	% RECOVERY:	97%
UNCORRECTED DEPTH (-FT):	-50.1	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+5.7	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 34.310
ACOE WATER LEVEL (TIDE):	+6.6	LONGITUDE:	122 20 42.349
WATER DEPTH ACOE MLLW:	~43.5	NORTHING:	213844.35
VESSEL:	R/V Nancy Anne	EASTING:	1267294.29
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny warm 75°F, Calm winds NE <5 knots.

18", +1" in pstn = 1.5   Core nose cut -.2

13.9 - 1.5 = 12.4

DEPTH Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–3.9		980039				ML/CL	Black to v.d. gray SILT with some CLAY and trace fine SAND very soft, wet shiny sheeny ~~surface~~ surface very strong H_2S odor 15ppm Hnu - ϕppm H_2S. (trace hair fibers? begin @ 2.0 to 3.9)
3.9–4.5		980038				ML/CL	3.9 to 4.5 very dark gray brown SILT with CLAY very sticky and very moist Hnu up to 5ppm soft.
4.5–7.9						ML	4.5 - 7.9 ~~verage~~ v.d. gray to BLACK SILT with trace CLAY and trace plant fibers, H_2S odor ϕppm Hnu 3ppm, moist, shinny sheen to sediment slight more firm than above.

Depth scale: 1, 2, 3, 4, 5, 6

REVIEWED BY: ______________________

SEDIMENT CORING LOG (page 2)

Core Number ED-12 (long, #1)

DATE SAMPLED:	8-3-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.2
TIME:	1213	% RECOVERY:	97%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY	OBSERVATIONS
		980038				ML	SILT (as above)	
1								
8						ML/CL	7.9 to 8.2 BLACK TO V.D. GRAY SILT with some CLAY, trace plant fiber and twigs. moist and soft. 2ppm Hnu	
		980203						
		archive "Z"				ML	BLACK to v.d. gray SILT with ~~trace~~ layers of fine sand. trace plant fibers thru-out v. soft sticky moist. Øppm Hnu	
9		Not Sampled						
10							10.4	
						SM	Black to v.d. gray fine SAND with some SILT moist soft.	
11								
12								

SEDIMENT CORING LOG (Core #2)

Core Number ED-12 (Short core)

DATE SAMPLED:	8/3/98	CORE PENETRATION:	6.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	6.4 ft - .2 = 6.2
TIME:	1145	% RECOVERY:	98%
UNCORRECTED DEPTH (-FT):	49.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+4.7	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 34.262
ACOE WATER LEVEL (TIDE):	+5.6	LONGITUDE:	122 20 42.301
WATER DEPTH ACOE MLLW:	43.4	NORTHING:	213839.42
VESSEL:	R/V Nancy Anne	EASTING:	1267297.48
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

13.9 - 7.1

40 = 7.5

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980039				ML/CL	v.d. gray to BLACK SILT with some CLAY w/ trace SAND very soft and very wet. sheen on water 25ppm of Hnu, 0ppm of H_2S. very strong odor. shinny: sheen on water 0 - 3.7'
1							
2							
3							
3.7							
4							
5							
6							

SEDIMENT CORING LOG

Core Number ED-13 core 1 (1 of 2)

DATE SAMPLED:	8/5/98	CORE PENETRATION:	14.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.9'
TIME:	1506	% RECOVERY:	85%
UNCORRECTED DEPTH (-FT):	~~-45.4~~ -47.3	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	~~+8.8~~ +9.1	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 36.002
ACOE WATER LEVEL (TIDE):	~~+9.8~~ +10	LONGITUDE:	122 20 42.196
WATER DEPTH ACOE MLLW:	35.6 37.3	NORTHING:	214015.55
VESSEL:	R/V Nancy Anne	EASTING:	1267308.14
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny winds N 5-10 70-75°F.

6' 17.9 - 6 = 11.9'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980052				ML/CL	BLACK SILT with some clay and trace fine sand very wet and very soft. Mussel shell @ 0.5' trace plant debris thru-out. Contamination staining visible on extruded sample surface. 20ppm ~~sta~~ sustained in core sample strong odor.
2.0						ML/CL ML/CL	@ 2' grades into SILT w/ ~~lots of~~ abundant clay v.d.gray trace angular clast (3mm in diameter) and trace plant debris (twigs 2-3" long), ~~very~~ soft and sticky. 20ppm sustained in core. Sample. wet
3.0						CL/ML	v.d. gray CLAY w/ some silt. no fine sand or plant debris - wet. soft lean clay
3.4'		980054				ML	d.gray SILT with trace fine sand wet and very soft and sticky trace clay. 0ppm
4.0						ML/SM	SILT ~~w/~~ SAND to SAND w/ SILT, trace plant debris, firm very moist poorly sorted no visible ~~sta~~ contamination
5.3						SM	grades into a fine SAND ~~with~~ SAND, g. brown with some silt, firm moist 0ppm Hnu
6.0							

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SEDIMENT CORING LOG

(2 of 2)

Core Number ED-13 core 1

DATE SAMPLED:	8/5/98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
		980054				ML/CL	SILT w/ CLAY, v.dark gray sticky moldable. Shiny sheen on surface of core. 3ppm in core when split open. ~~very~~ wet.
7						CL/ML	CLAY (lean) with little silt dark gray brown sticky firm Øppm CLAY TO 7.9'
8						SM	7.9 grades into v. poorly sorted mix of v. fine SAND ~~SILT~~ silt w/ trace clay. very moist firm v. dark gray. Øppm
						CL/ML	8.5 CLAY (lean) w/ little silt d.g. brown, sticky moist firm. grades into v. fine sand @≈9.2' Øppm
9						SP-SM	9.2 V.f. SAND with some SILT stiff, dense with increase in plant debris from trace @ 9.2 to 9.9. large rootwigs 1-3" long ~~from~~ 9.9 to 11.4
10						SP-SM	10.0 SAND fine to medium w/ little silt. moist to very moist. med. dense. coarsening downward less fines with depth. Øppm
11							11.4
6							

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SEDIMENT CORING LOG

SAIC

Core Number ED-13 (core 2)

DATE SAMPLED:	8/5/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	6.5 - 0.2 = 6.3
TIME:	1335	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT): -44.3	-44.3 STET	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE): +5.3	+5.3 STET	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 36.006
ACOE WATER LEVEL (TIDE):	+6.2	LONGITUDE:	122 20 42.486
WATER DEPTH ACOE MLLW: -38.1	-38.1 STET	NORTHING:	214015.73
VESSEL:	R/V Nancy Anne	EASTING:	1267288.26
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, 75°F calm little wind

6.5 - 0: * Cut nose off -0.2

DEPTH Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–0.9		980052				ML / SM	v.d. gray SILT (fine) with SAND, with trace clay very soft, wet. 30ppm sustained Hnu readings in sample. strong odor.
0.9–2.0						ML	0.9 grades into a SILT, graybrown with trace fine sand and little clay, trace plant debris 15ppm needle defection of Hnu. moist to wet sticky. soft.
2.0–2.8						ML	2.0 SILT, gray brown with little v.f. sand trace clay flacks of biotite? muscovite? throut moist 0ppm of Hnu. slightly firmer than lower section of core.
2.8–4.0						ML	2.8 SILT, v.d. gray to black with little fine sand and ~~some~~ little plant debris (small twigs and rootlets). moist and firm. 5.8 ppm Hnu defection. possible contamination.
4.0							4.0 (bottom of described core)

REVIEWED BY: ______

SEDIMENT CORING LOG

Core Number ED-14 core 1 (page 1)

DATE SAMPLED.	8/3/98	CORE PENETRATION:	12.75 (nose)
LOCATION:	East Waterway - Seattle. WA	CORE RECOVERY:	12.3 - .2 = 12.1
TIME:	0917	% RECOVERY:	96%
UNCORRECTED DEPTH (-FT):	-44.8	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	1.1	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 29.762
ACOE WATER LEVEL (TIDE):	2.0	LONGITUDE:	122 20 40.946
WATER DEPTH ACOE MLLW:	-42.8	NORTHING:	213381.72
VESSEL:	R/V Nancy Anne	EASTING:	1267381.41
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny 70°F, Calm

? Debris 10-10.5' ? 2" off w/nose

19" ~1.6

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–3.8		980036 (comp. w/ ED-14#2)	3.8		ML/CL		(0 to 3.8 ft): Black to dark gray SILT and CLAY with trace trash (hair) material. Soft. H_2S odor (HNu = up to 50 ppm) in middle of core (~1.5-2 ft depth is highest). Orange thin worms in upper 2 inches.
3.8–6		980035 (comp. w/ ED-9 #1)			ML		—(3.8)— (3.8-7.8 ft): Dark gray SILT with little clay. Clay-rich closer to top, becoming siltier toward bottom (with trace fine sand near base). Rare small white shells in silt (~1 ft above base) @ ~7.0 ft. Weak petroleum odor at ~4-5 feet. Firm. Very moist.

8.4
7.8

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SEDIMENT CORING LOG (page 2)

Core Number ED-14 (core 1)

DATE SAMPLED:	8-3-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INTERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980035 (comp. w/ ED-9 #1)			ML		SILT (see above) w/ little clay
1 (7)							
2 (8)					ML		(7.8) (gradational) DK gray SILT, with trace wood/plant debris and possible trash (unclear). Firm. Very moist
3 (9)		980201 "Z"	8.8		ML/SP		8.8 (gradational) Dark gray Sandy SILT, with common wood/plant fragments (wood up to 3 inches long). very firm, moist.
4 (10)		Not Sampled	9.8		SP		9.8 (gradational) DK gray SAND with trace silt, with common wood/plant fragments (up to 4"). Dense to v. dense. Moist.
5 (11)							
6 (12)							12.1 (bottom of core)

SEDIMENT CORING LOG

Core Number ED-14 core 2

DATE SAMPLED:	8/3/98	CORE PENETRATION:	6.0 -1 ft 4.3
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	~~4.3~~ 4.4
TIME:	0948	% RECOVERY:	~~66~~ 73.2
UNCORRECTED DEPTH (-FT):	-45.5	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	1.5	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 29.631
ACOE WATER LEVEL (TIDE):	2.4	LONGITUDE:	122 20 40.942
WATER DEPTH ACOE MLLW:	-43.1	NORTHING:	213368.45
VESSEL:	R/V Nancy Anne	EASTING:	1267381.43
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

5.5 ft free fall 6ft 5" core length

25 in 1.5 inches cut off w/ core nose

DEPTH Feet Below Mud Surface	DEPTH Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INTERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1		980036 (comp. w/ ED-14 #1)			ML/CL		(0-4.3 ft). Black to dark gray SILT and CLAY, with silt content increasing downward, trace trash (hair) material and plant debris. Soft (barely firm near bottom), V. Sticky. Petrol. odor in upper half, also H_2S odor. HNu reads up to 6 ppm. All silt below ~2.9 feet.
2							
3			2.9				-(2.9)- - (gradational) - - -
3–4		Not Sampled			ML		SILT, clay decreases or is absent
4							-4.3 — (bottom of core) —
5							
6							

REVIEWED BY: ______________________ PAGE 1 OF 1

SEDIMENT CORING LOG

(page 1)

Core Number ED-17 (long) (core #1)

DATE SAMPLED:	8/3/98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	10.4 - 0.2 = 10.2
TIME:	1350	% RECOVERY:	83%
UNCORRECTED DEPTH (-FT):	-52.9	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	8.2	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 34.282
ACOE WATER LEVEL (TIDE):	9.1	LONGITUDE:	122 20 40.516
WATER DEPTH ACOE MLLW:	43.8	NORTHING:	213839.11
VESSEL:	R/V Nancy Anne	EASTING:	1267416.46
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny - 80°F, calm winds <5 knots NE

42" = 3.5   0.2 - core nose

13.9 - 3.5

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980040			ML/CL		(0-3.3 ft): Black to very dark gray CLAY and SILT, with trace trash (hair) debris and plant material. Strong H_2S odor. HNu = 60ppm max (upper half mostly). Soft. Sticky.
3.3		980038				CL/ML	(3.3) ~~very~~ very dark gray to greenish gray CLAY with silt, very soft strong H_2S odor
4.3						ML/CL	@4.3' BLACK to very dark gray SILT with clay with possible contamination (sheen) Hnu to 4.5ppm. Slightly more firm than CLAY @ 3.3'
5.2						ML	@5.2 to 6.8 BLACK to v.d. gray SILT with trace plant fibers and possible contamination. trace of fine sand, moist.
6.8							6.8 to 7.3 Archive, same as 5.2 to 6.8' bgs

Depth scale: 1, 2, 3, 4, 5, 6

SEDIMENT CORING LOG (page 2)

Core Number ED-17 (long, core #1)

DATE SAMPLED:	8-3-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.9
TIME:	1419	% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980038				ML/CL	7.3-7.6 BLACK TO v.d. gray SILT w/CLAY, trace plant fiber & contamination, very soft. (STICKY)
7		980204 archive "Z"					
		Not Sampled				ML/CL	7.6-~~10.2~~-8.6 AS ABOVE
8							8.6 to 10.2 BLACK to v.d gray SAND with SILT. very fine layering pattern thruout with trace fibers thruout section. moist soft. no odor
9						SM	
10							10.2
5							
6							

REVIEWED BY: ______

SEDIMENT CORING LOG

Core Number ED-17 short (core #2)

DATE SAMPLED:	8/3/98	CORE PENETRATION:	6.5'
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.9
TIME:	1419	% RECOVERY:	91%
UNCORRECTED DEPTH (-FT):	53.4	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	8.7	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	4734 34.347
ACOE WATER LEVEL (TIDE):	9.6	LONGITUDE:	12220 40.466
WATER DEPTH ACOE MLLW:	43.8	NORTHING:	213845.56
VESSEL:	R/V Nancy Anne	EASTING:	1267423.44
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

7" = 0.6

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–3.6		980040			ML/CL		(0-3.6 ft): Black to very dark gray SILT and CLAY, with small amounts of trash debris (hair) and plant material, one 1-inch brown oblong bivalve at 2 ft. Strong H_2S odor. H_2S = 75 ppm max (mostly in upper half. Soft. Very sticky. 75
3.6		980038 ML					(3.6 ft) Bottom of described core

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SEDIMENT CORING LOG (page 1)

Core Number ED-21 (core 1)

DATE SAMPLED:	8/5/98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.9 - 0.2 = 11.7
TIME:	0824	% RECOVERY:	95%
UNCORRECTED DEPTH (-FT):	-44.4	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+0.4	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 33.790
ACOE WATER LEVEL (TIDE):	+1.3	LONGITUDE:	122 20 32.923
WATER DEPTH ACOE MLLW:	-43.1	NORTHING:	213785.71
VESSEL:	R/V Nancy Anne	EASTING:	1267596.66
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Clear, sunny 63°F calm.

*Core nose cut of -0.2' — compacted silty sand in nose.

24" = 2.0' 13.9 - 2 = 11.9

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INTERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–3.8		980051 (Comp. w/ ED-~~21~~#3 + #2)			ML		(0 to 3.8 ft): Very dark gray SILT, with little clay, trace fine sand. Sand mainly occurs at 1.5-1.9 feet. Strong H_2S odor. HNu reads up to 5ppm in silt in upper half, up to 40 ppm in central sand. Trace trash/leaf debris throughout. Tube worm in top few inches. Soft.
3.8–6		980049 (comp. w/ ED20 #1)	3.8		ML		(3.8) (3.8 - 7.8 ft): Medium to very dark gray SILT with some CLAY, with trace amounts of trash. Soft at top grading down to firm. Very sticky in upper half.

5
40

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SEDIMENT CORING LOG

(page 2)

Core Number ED-21 #1

DATE SAMPLED:	8-5-98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.7
TIME:	0824	% RECOVERY:	95%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980048			ML		SILT with some clay (see above)
7							
8					ML		(7.8) Dark brown-gray SILT, laminated, with common hair debris and some plant material. Firm.
		980208 "Z"	8.5				
9			9.4		ML		9.0 Dark brown-gray SILT with some very fine sand, with trace plant or hair fibers. Very firm.
		Not Sampled					
10							
					SP-SM		10.5 (10.5 - 11.7 ft): Fine to med SAND with little silt, trace hair (probably). Dense. Dark gray.
11							
							11.7 — (bottom of core)
12							

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only if necessary

SEDIMENT CORING LOG

Core Number ED-21 (core 2)

DATE SAMPLED:	8/5/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	2.8
TIME:	1115	% RECOVERY:	47%
UNCORRECTED DEPTH (-FT):	~~+0.5~~ 45.3	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+0.5	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 37.759
ACOE WATER LEVEL (TIDE):	+1.4	LONGITUDE:	122 20 37.994
WATER DEPTH ACOE MLLW:	-43.9	NORTHING:	213782.66
VESSEL:	R/V Nancy Anne	EASTING:	1267591.73
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	P.C. Sunny, 65°F, calm winds <5 knots W/SW

3'8" = 3.7

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1		980051 (Comp w/ ED-21 #2+3)			ML/CL		(0 to 2.8 feet); Black to dark gray, SILT and CLAY, with some fine Sand. Sand is only in interval 1.0 - 1.3 ft, gradational contacts. Rare trash/hair debris. Soft. Tube worm ~~mats~~ in top few inches. (Sed's at top inch become lighter gray, as do other cores, so the 2.8 feet appears to begin at the sed surface and continue down in continuity.)
1–2			1.9				
2		Not Sampled					
2.8			~~2.8~~				2.8 (Bottom of core)
3							
4							
5							
6							

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SEDIMENT CORING LOG

Core Number ED-21 (core 3)

DATE SAMPLED:	8/5/98	CORE PENETRATION:	6.0'
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	4.5 - 0.2 = 4.3
TIME:	1135	% RECOVERY:	75%
UNCORRECTED DEPTH (-FT):	- 44.6	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+0.9	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 33.705
ACOE WATER LEVEL (TIDE):	+1.8	LONGITUDE:	122 20 38.026
WATER DEPTH ACOE MLLW:	- 42.8	NORTHING:	213777.24
VESSEL:	R/V Nancy Anne	EASTING:	1267589.43
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	P.C. winds SW 5 Knots 70°F Sunny

24" = 2'
6.5 - 2.0 = 4.5
* Cut off shoe -0.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INTERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980051 (comp. w/ ED-21 #1 + #2)			ML		(0 to 4.3 ft): Medium to very dark gray SILT, with some clay, and little very fine to fine sand. Sand occurs only from 0.5 to 1.1 feet, and is mixed w/ silt there. Soft. Some worms in upper inch, trace trash (hair) debris throughout. H_2S odor in upper half
1							
2							
3			3.0				
3		Not Sampled					
4							
4.3							4.3 ft (Bottom of core)
5							
6							

SEDIMENT CORING LOG

SAIC

Core Number ED-23 (core 1) (p.1)

DATE SAMPLED:	8/10/98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	10.8 - 0.2 > 10.6
TIME:	0833 - 0837	% RECOVERY:	90%
UNCORRECTED DEPTH (-FT):	- 51.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+ 8.4	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 40.714
ACOE WATER LEVEL (TIDE):	+ 9.3	LONGITUDE:	122 20 37.371
WATER DEPTH ACOE MLLW:	- 41.7	NORTHING:	214486.40
VESSEL:	R/V Nancy Anne	EASTING:	1267648.27
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	P.C. Sunny 65F, winds w/sw 5-10 knots.

2-6' pen - hit something hard.
37" = 3.1
* Cutoff nose -0.2

Sulfide odor from TOP, silty F. sand in nose.

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.3		980061				ML	SILT, with trace fine sand, trace rootlets, very soft and wet dark gray brown to black, sheen on standing water very strong sulfur odor. 50ppm when core was opened and 20ppm sustained after it was opened visible contamination.
1.3						ML	
						GW	large rounded cobble @ 1.7' bgs, csc gravel layer from 1.7-2' bgs
2.1						ML / SM	2.1 grades into a very silty sand or sandy SILT very moist gray brown 5ppm when opened. trace plant debris.
3.6 (MID SEC)		980060 field dup 980065				ML	SILT, with trace fine sand, trace clay. Very wet & soft with some large well rounded cobble (2-5 inches long) dark gray olive. ~~good~~ trace rootlets no odor and no PID reading through-out core.
5.8						SM	VERY FINE SAND, with some silt and trace clay. 5.8-6. dark brown-gray, soft to firm and moist

SEDIMENT CORING LOG

Core Number ED-23 (core 1) (p. 2)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS	
6		980060				SM	FINE SAND with some silt. Dark gray & moderately moist. moderately sorted. Soft	
7						SP-SM	FINE SAND, with little silt. Dark gray & moderately moist. moderately sorted. Soft.	7.1
						SM	FINE SAND with some silt, Soft 7.6 - 8.7 Dark grayish-brown. Moist w/ trace rootlets.	Bott SE. ↓
8								
9						ML	SILT with some fine sand, Dark grayish-brown. Moist and interbedded bands of sand. from 8.6 - 10.6.	8.6
						SM	Band of sand, with some silt from 9 - 9.3 ft	9.3
							9.5 - becomes firmer.	9.5
10		980215 archive					no odor or PID reading through-out core.	
		"Z"						
5								
6								

SEDIMENT CORING LOG ⊛

Core Number FD-23 (core 2)

DATE SAMPLED:	8/10/98	CORE PENETRATION:	5'
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	3.2
TIME:	0923	% RECOVERY:	64%
UNCORRECTED DEPTH (-FT):	-49.9	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+6.8	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 40.642
ACOE WATER LEVEL (TIDE):	+7.7	LONGITUDE:	122 20 37.218
WATER DEPTH ACOE MLLW:	-42.2	NORTHING:	214478.90
VESSEL:	R/V Nancy Anne	EASTING:	1267658.61
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	P.C. Sunny, 65°F calm winds w/SW 5 knots

Water poured out end. Use last.

3'4" * Core nose still on.

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.3		980061				ML	SILT, with little v. fine sand with trace to little plant rootlets and woody debris, very soft, very moist to wet, strong H_2S odor 100ppm when opened. 100ppm → black
1.3–3.2		980061				ML	SILT, as above but and increase to some plant debris and some hair fibers through core sample. soft, moist, looks like sheeny core surface ~~set~~ strong petroleum odor 20ppm in core when opened.
~2.6–3.2		Not sampled					
3.2							3.2

Depth scale: 1, 2, 3, 4, 5, 6

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PAGE 1 OF 1

SAIC

SEDIMENT CORING LOG

Core Number FD-23 (core 3)

DATE SAMPLED:	8/10/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	4.5
TIME:	0938	% RECOVERY:	75%
UNCORRECTED DEPTH (-FT):	-47.9	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	6.2	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 40.825
ACOE WATER LEVEL (TIDE):	7.1	LONGITUDE:	122 20 37.392
WATER DEPTH ACOE MLLW:	40.8	NORTHING:	214497.67
VESSEL:	R/V Nancy Anne	EASTING:	1267647.05
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Winds SW 5 knots, 65°F P.C. Sunny.

~4-5 meters north of point.
– hit gravel at 4' penetration.

* Core nose still on.

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1		980061				ML	SILT, with little v. fine sand and trace plant debris, very soft and wet, one goast shrimp @ 0.8'. v.d. gray brown
1–2		↓				ML/CL	SILT, with some v. fine sand and little clay trace plant rootlets ~20ppm in this section of core when opened. soft to firm very moist to wet somewhat moldable. v.dgray to black.
2–3		↓				ML/CL	CLAYEY SILT, some clay and trace v. fine sand. very sticky soft to firm, moldable. able to roll material into 1/4" strings very moist plastic. dark gray.
3–6							

1.0 – 3.0 increasing clay content

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(page 2)

SEDIMENT CORING LOG

Core Number ED-30 (core 1)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
		980118				ML	SILT, with little sand and some clay. stiff olive brown. moist, trace rootlets and twigs.	
7						ML	[move above description to here]	
							END OF CORE SECTION	
8						~~ML~~	SILT as ABOVE	8.1
						SM/ML	SAND, fine, with lots of silt v.d. olive gray brown.	
9								no odor
							decreases in silt	
10					SP-SM		SAND, fine with little silt. v.d. olive gray brown ~~hard~~ dense, moist	10.1
						SM/ML	SAND, fine with lots of silt, dense moist. gray brown to olive gray brown.	
11								
							END OF CORE SECTION	
12								

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SEDIMENT CORING LOG

(page 3)

Core Number ED 30 (core 1)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
12		980118				SM/ML	SAND, and SILT, as above	
						OL	ORGANIC RICH LAYER (TWIGS)	12.8
13		archive "2"				SM/ML/CL	SAND, fine with silt interbedded with silt and clay. v.d. gray brown.	
		980250				SP-SM	SAND, fine to medium with little silt v.d. gray brown. dense to loose. v.d. gray brown. moist moderately sorted.	.5
14		Not Sampled						
15							BOTTOM OF CORE	15.:
16								
5								
6								

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SEDIMENT CORING LOG

SAIC

Core Number ED-30 (core 2)

DATE SAMPLED:	8/20/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.7
TIME:	1433	% RECOVERY:	95%
UNCORRECTED DEPTH (-FT):	45.6	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	6.6	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 35 27.226
ACOE WATER LEVEL (TIDE):	7.5	LONGITUDE:	122 20 36.517
WATER DEPTH ACOE MLLW:	38.1	NORTHING:	219197.10
VESSEL:	R/V Nancy Anne	EASTING:	1267799.28
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear, calm, P.C. 70-75°F low winds

10" = 0.8
6.5 - 0.8 = 5.7 * Cut to 3.8' *

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INTERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS	
0–0.5		980117				ML/CL	~~SI~~ SILT w/ clay and trace v.f. sand, trace rootlets very soft, moldable. lite olive brown. wet. strong H2S odor	0.5
0.5–2.3						ML/CL	SILT & CLAY, AS ABOVE, slightly firmer and black ~~in color~~. to olive brown in color wet.	
						ML/CL		2.3
2.3–2.8						ML/CL	SILT with clay and trace v.f. sand firm to stiff. trace rootlets, wet.	2.8
2.8–3.8						CL	CLAY, soft to slightly firm, very sticky homogenous texture, gray, moist.	3.8

Depth scale: 1, 2, 3, 4, 5, 6

REVIEWED BY: ____________ PAGE 1 OF 1

SEDIMENT CORING LOG (page 1)

Core Number ED-34 (...)

DATE SAMPLED:	3/4/98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.5
TIME:	1412	% RECOVERY:	92%
UNCORRECTED DEPTH (-FT):	-54.5	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	8.1	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 30.770
ACOE WATER LEVEL (TIDE):	9.0	LONGITUDE:	122 20 36.565
WATER DEPTH ACOE MLLW:	45.5	NORTHING:	213477.94
VESSEL:	R/V Nancy Anne	EASTING:	1267683.74
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Clear Sunny 70°F winds 10 knots N

29" = 2.4'
13.9 - 2.4

DEPTH Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980044			ML/CL		v. dark gray to black SILT with some clay very soft and moist, sticky Øppm Hnu Øppm H_2S
1.7					SM		1.7' SILT above grades into a SAND, medium to fine, dark gray brown with silt. med dense, moist to wet and poorly sorted.
3.7		980043			SM		dark gray brown med. SAND with some silt loose, wet and trace plant debris. 3.7 to 5.5' Øppm Hnu
4							SAND, as above
5.5					SM		5.5 to 6.2' Grades into SAND with lots of silt V. dark gray to black wet, loose

Depth scale: 1, 2, 3, 4, 5, 6

SEDIMENT CORING LOG (page 2)

Core Number ED 34 (core 1)

DATE SAMPLED:	8-4-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
6		Archive "Z"				SM	SAND with Silt (as above) 6.2
		980206				ML	V. dark gray SILT with some clay, trace sand, med. soft, moist -1ppm on HNu
7		Not Sampled					7.
						SM	(7.2-8.2) Brownish gray SAND, med grained, with silt, med. dense, wet, poorly sorted sand.
8							(bottom of described core = 8.2 ft)
							(Did not need to sample bottom - discard)
8							
4							
5							
6							

REVIEWED BY: ______

DIV0440\EASTWATERWAY\CORELOG.DSF 7/24/98

SEDIMENT CORING LOG

Core Number ED-34 (core 2)

DATE SAMPLED:	8-4-98	CORE PENETRATION:	6
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	4.1
TIME:	1446	% RECOVERY:	68%
UNCORRECTED DEPTH (-FT):	-55	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	8.9	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 30.739
ACOE WATER LEVEL (TIDE):	9.8	LONGITUDE:	122 20 36.797
WATER DEPTH ACOE MLLW:	45.2	NORTHING:	213475.11
VESSEL:	R/V Nancy Anne	EASTING:	1267667.78
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

Hit something @ 2' depth

29" = 24

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1		980044				ML/CL	SILT with clay, black to v. dark gray, trace plant debris throughout, very soft, wet
1							(gradational) 1.1
1–2						SM	SAND with silt, trace subrounded fine gravel throughout, poorly sorted, med. dense, dark gray brown, medium-grained sand. HNu = Øppm
2–2.7			2.7				2'
2.7–4		980043				SM	Med to Fine SAND, with silt, poorly sorted, med dense, wet, gray brown. HNu = Øppm.
4.6			4.6				4
5							
6							

REVIEWED BY: ____________ PAGE 1 OF 1

SEDIMENT CORING LOG

SAIC

Core Number ED-34 (core 3)

DATE SAMPLED:	3/5/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	2.75 - 0.2 = 2.55
TIME:	1359	% RECOVERY:	46%
UNCORRECTED DEPTH (-FT):	-51.2	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+6.5	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 30.667
ACOE WATER LEVEL (TIDE):	+2.4	LONGITUDE:	122 20 36.863
WATER DEPTH ACOE MLLW:	-43.8	NORTHING:	213467.91
VESSEL:	R/V Nancy Anne	EASTING:	1267663.11
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, winds n 5-10 knots 20-25°F

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
							3'4" = 3.75 6.5 - 3.75 = 2.75 Cut core nose = -0.2 * Hit something @ 2' Material is likely all surface (<4') Also lost water out bottom. Very sandy material @ bottom.
0		980044			ML/CL		(0-1.1 ft): Very dark gray SILT and CLAY, soft. HNu = zero
1		↓					1.1 ft (very sharp contact)
					SP		(1.1-2.0 ft): Olive-gray, fine to med SAND, clean, but with trace silt in "pockets". Occassional coarse sand to granule. ~~Soft to~~ Loose to med. dense. HNu = zero.
2							2.0 (Bottom of described core at 2.0 ft)
3							
4							
5							
6							

REVIEWED BY: ______________________

SAIC

SEDIMENT CORING LOG (page 1)

Core Number ED-36 (core 1)

DATE SAMPLED:	8/13/98	CORE PENETRATION:	20.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	~~20.6~~ 19.7 - 0.2 = 19.5
TIME:	1502	% RECOVERY:	96%
UNCORRECTED DEPTH (-FT):	38.9	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	3.1	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 41.887
ACOE WATER LEVEL (TIDE):	+4.0	LONGITUDE:	122 20 36.664
WATER DEPTH ACOE MLLW:	34.9	NORTHING:	214604.27
VESSEL:	R/V Nancy Anne	EASTING:	1267649.06
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear 75-80°F winds N 5-10 knots

26" = ~~1.7~~ 2.2   Cutoff nose -0.2'

21.9 - 2.2 = 19.7

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980089 (Comp w/ ED-36 #2)			ML/CL		(0 to 3.8 ft): Very dark gray SILT and CLAY with trace vf sand. Common plant material and trash (hair). Soft. Wet.
1							
2							
3							
3.8			3.8				(3.8)
4		980091 (Comp, w/ ED-50 #1)			ML/CL		Similar to above; (3.8 - 7.8 ft): Dark gray SILT and CLAY, with little fine-vf sand. Common shells, plant debris, and a little hair debris. Weak petrol odor in upper foot (3.8-4.8 ft depth). Soft to firm. Rare gvl (rounded, to 0.8 inch). Sticky & very moist.
5							
6							

16.4
17.3

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REVIEWED BY: ____________

SEDIMENT CORING LOG (Page 2)

Core Number ED-36 (core 1)

DATE SAMPLED:	8-13-98	CORE PENETRATION:	20.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	19.5
TIME:	1502	% RECOVERY:	96%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980091 (comp. w/ ED-SD #1)			ML/CL		SILT and CLAY (see above) very moist
1 7							
							(7.8)
2 8					ML/CL		SILT and CLAY (see above) very moist
3 9							
							9.3 — — — (gradational, color change) — — —
					ML		SILT, with common plant fiber debris and hair debris. Dark brownish. Soft to firm. Moist.
4 10							
1							
							10.8
5 11					ML/SM		SILT and very fine SAND (a little fine sand) Some plant debris and hair. Mod. dense. Dark gray. Silt and sand occur primarily intermixed instead of segregated by layers.
							(11.8)
6 12							

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SEDIMENT CORING LOG (page 3)

Core Number ED-36 (cont.)

DATE SAMPLED:	8-13-98	CORE PENETRATION:	20.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	19.5
TIME:	1502	% RECOVERY:	96%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
12		980091 (comp. w/ ED-SD#1)			ML/SM		SILT and SAND (as above)
1 13							13.1
					ML		SILT with some vf (~15-20%) Sand, occurring as interbeds in silt. Very Firm. Very moist. Minor plant material and hair debris. Dark gray to very dark gray.
2 14							
3 15							
							(15.8)
4 16			16.4		ML		SILT (as above), but with less sand, and lighter color: - little sand (~7%), very fine mostly. Some small shells. Very firm, Dark brown-gray.
		980233 "Z"					
5 17			17.3				
		Not Sampled					
6 18							Same down to bottom of core at 19.5 feet)
							19.5

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SEDIMENT CORING LOG

Core Number ED-36 (core 2)

DATE SAMPLED:	8/13/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	6.0
TIME:	1152	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	42.9	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	7.6	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 41.972
ACOE WATER LEVEL (TIDE):	+8.5	LONGITUDE:	122 20 36.455
WATER DEPTH ACOE MLLW:	34.4	NORTHING:	214612.60
VESSEL:	R/V Nancy Anne	EASTING:	1267713.56
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, Clear 70-75°F winds NW 5 knots

6" = 0.5

6.5 - 0.5 = 6.0

* Cut to 4'

Sheen present in discarded section.

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–4		980089 (comp w/ ED-36 #1)	4.0		ML/CL		(0 to 4.0 feet): SILT and CLAY (probably mostly silt) with trace vf sand, common plant debris and trash (hair) debris. Soft. Wet, V. dk gray. HNu = zero (unclear if operating proper)
4							4.0 (Bottom of core)
5							
6							

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SEDIMENT CORING LOG (1 of 2)

Core Number ED-38 (core 1)

DATE SAMPLED:	8-20-98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.2 - 0.2 = 12.0
TIME:	1106	% RECOVERY:	100 %
UNCORRECTED DEPTH (-FT):	42.3	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	-0.8	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 48.392
ACOE WATER LEVEL (TIDE):	+0.1	LONGITUDE:	122 20 36.558
WATER DEPTH ACOE MLLW:	42.1	NORTHING:	215263.11
VESSEL:	R/V Nancy Anne	EASTING:	1267719.26
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	clear, sunny 60-65°F winds N 5 knots

21" = 1.75

13.9 - 1.75 = 12.2

* cut off nose -0.2'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0–2.5		980111				ML/CL	SILT and CLAY, with trace fine sand, very sticky, very soft, wet, sheen on water surface, strong H_2S odor, possible petroleum odor?
2.5–3.6						ML/CL	This (2.5-3.6') zone contains a lot of hair fiber, rootlets, and a strong petroleum odor; black, wet, soft, sheen on water. -HNu = 10 ppm
3.6–4						ML/CL	(3.6) SILT with clay and some fn sand, firm, sticky, very dark gray brown to black.
4–6		980113 980115 (field dup)				CL	CLAY, stiff, moldable, easily rolled into thin stringers, moist, dark olive gray, no odor. 4-8' = homogeneous texture

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SEDIMENT CORING LOG

Core Number ~~ED~~-38 (core 1) (2 of 2)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
		980113				CL	CLAY, as above	
7								
8						SM	<u>SAND</u>, fine with silt and clay, slightly ~~moldable~~ with trace rootlets grayish ~~brownish~~ reddish brown. moist / dense.	8.[illegible]
						OL	grades into a <u>large piece of wood 5 inches long</u>	8.5
9						SM	<u>SAND</u>, fine to medium, with some silt dense to very dense, trace rootlets, moist to wet. grayish reddish brown. moderate to poorly ~~gr~~ sorted.	8.9
10		Archive "Z"						
		980246						
11		Not Sampled						
12								

REVIEWED BY: ______________

SAIC

SEDIMENT CORING LOG

Core Number ~~ED~~ ED-38 (core 2)

DATE SAMPLED:	8/20/98	CORE PENETRATION:	6.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.7
TIME:	0816	% RECOVERY:	88%
UNCORRECTED DEPTH (-FT):	44.4	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	2.2	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 48.377
ACOE WATER LEVEL (TIDE):	3.1	LONGITUDE:	122 20 36.586
WATER DEPTH ACOE MLLW:	41.5	NORTHING:	215261.63
VESSEL:	R/V Nancy Anne	EASTING:	1267717.31
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Mostly clear, sunny, 55-60°F calm, light winds W < 2 knots

10" = 0.8'
6.5 - 0.8 = 5.7

88% of 4' = 3.5'
Cut to 3.5'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–0.9		980111				ML/CL	SILT with some clay and trace f. v. f. sand trace rootlets and shell fragments, worm tubes, v. soft strong H_2S odor. d. olive gray to black, wet
0.9–1.1		↓				ML/CL	SILT, as above with string or fishing line
1.1–2.5		↓				ML/CL	SILT; CLAY, as above
2.5–3.3		↓				ML	SILT, with lots of "needle like" twigs, woody debris, very soft, black. strong petroleum smell 10ppm on Hnu. wet. sheen on water.
3.3–3.9		↓				ML/CL	SILT and clay with trace sand. very soft sticky. brown, wet
4							3.9'
5							
6							

Right margin depth marks: 2.5, 3.3, 3.9

REVIEWED BY: ____________ PAGE 1 OF 1

SEDIMENT CORING LOG (page 1)

Core Number ED-39 (core 1)

DATE SAMPLED:	8-12-98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.4 - 0.2 = 11.2
TIME:	1035	% RECOVERY:	95 %
UNCORRECTED DEPTH (-FT):	49.2	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	8.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 51.073
ACOE WATER LEVEL (TIDE):	8.9	LONGITUDE:	122 20 36.413
WATER DEPTH ACOE MLLW:	40.3	NORTHING:	215534.52
VESSEL:	R/V Nancy Anne	EASTING:	1267734.53
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear, 70°F, calm winds N 5-8 Knots

30" = 2.5
13.9 - 2.5 = 11.4

* Cut off nose -0.2'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.5		980078 (comp. w/ ED-39 #2)			ML/CL		(0-1.5 ft): Light to v. dk. gray (in layers) SILT and CLAY with some plant debris, possibly a little trash, soft, wet.
1.5–3.2					ML		(1.5-3.2 ft): Dark gray SILT with some very fine sand, and abundant plant material (straw/hay-like mostly) in layers. Firm. Laminated, fissile
3.2							(very gradational)
3.2–7.4		980080 (comp. w/ ED-53 #1)	3.8		ML		(3.2-7.4 ft): Dark gray SILT, with trace very fine sand which decreases downward. Laminated, fissile, due to abundant plant debris (unnatural probably) straw/hay in layers. Soft to firm, moist.

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DWG/EASTWATERWAYCORELOG.DSF 7/24/98

SEDIMENT CORING LOG (page 2)

Core Number ED-39 (core 1)

DATE SAMPLED:	8-12-98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.2
TIME:	1035	% RECOVERY:	95%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980080 (comp. w/ ED-53 #1)			ML		SILT (see p. 1) - (3.2 to 7.4 ft)
7							
							7.4 — (7.4 to 10.1 feet):
					ML/CL		(7.8) Dark (slightly brownish) gray SILT and CLAY with rare plant debris. Barely firm. Moist. Massive
8							
9							
10							10.1 —
					ML		Dark brown-gray SILT grading down to SAND, interbedded and laminated. Sand is vf to fine. A bit of plant/wood debris. Firm, dense.
11			11.2		SP		11.2 — (Bottom of core)
							- No archive "Z" sample due to not enough sample in core. All this core used for regular ~~current~~ samples.
12							

SEDIMENT CORING LOG

Core Number ED-39 (core 2)

DATE SAMPLED:	8/12/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	6.1 - 0.2 = 5.9
TIME:	0914	% RECOVERY:	100%.
UNCORRECTED DEPTH (-FT):	50.9	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+9.6	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 51.052
ACOE WATER LEVEL (TIDE):	+10.5	LONGITUDE:	122 20 36.471
WATER DEPTH ACOE MLLW:	40.4	NORTHING:	215532.47
VESSEL:	R/V Nancy Anne	EASTING:	1267730.51
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny Clear 65-70°F Calm

5" = .4
6.5 - .4
Cut off nose -0.2'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980078 (comp. w/ ED-39#1)			ML		(0 to 2.5 ft): SILT with some clay, and trace vf sand; somewhat common plant debris and trash, Very dark gray (a little light gray bands). Soft, Wet. HNu = zero, H_2S = zero, Strong H_2S odor.
1							
2							
2.5					ML		2.5 ft (2.5 to 4.0 ft): SILT with little vf sand and abundant plant debris. Very laminated due to plant material in layers. Firm.
3							
4			4.0				(4.0) (Bottom of described core)
5							
6							

REVIEWED BY: ______________________ PAGE 1 OF 1

SEDIMENT CORING LOG (page 1)

Core Number ED-40 (core 1)

DATE SAMPLED:	8/11/98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.1 − 0.2 = 10.9
TIME:	1446	% RECOVERY:	91%
UNCORRECTED DEPTH (-FT):	44.3	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+ 0.8	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 56.274
ACOE WATER LEVEL (TIDE):	+ 1.7	LONGITUDE:	122 20 36.332
WATER DEPTH ACOE MLLW:	− 42.6	NORTHING:	216061.29
VESSEL:	R/V Nancy Anne	EASTING:	1262750.42
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, P.C 70°F wind WS-10

34" = 2.8' ✱ Cutoff nose −0.2'

13.9 − 2.8 = 11.1

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980075 (comp. w/ ED-40#2)			ML		(0 to 2.4 ft): Dark gray, Sandy SILT, with little gravel (up to 1.5 inches, subrounded). Unusual appearance/texture. Fragments of trash (wood chips, hair) and plant debris present; worm tubes. Sand is vf to medium. Soft to firm.
2.4							(sharp contact)
					SP		Dark (olive) gray, fine to med SAND (mostly fine) clean. Loose, slightly cohesive. Sand coarsens down to a medium sand at the lower contact, maybe some coarse sand too. (HNu = zero)
3.6		980076 (comp w/ ED-55#1)	3.6				(3.6)
4.1							(sharp contact)
					ML/CL		Very dark gray SILT and CLAY, with common trash and plant debris. Fuel(?) ~~odor~~ in silt at about 5−5.5ft, along with HNu readings up to 11 ppm. Well-laminated. Firm. Trace fine sand.
6							

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SEDIMENT CORING LOG (page 2)

Core Number ED-40 (cont)

DATE SAMPLED:	8-11-98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	10.9
TIME:	1446	% RECOVERY:	91%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980076 (comp. w/ ED-55#1)			ML/CL		SILT and CLAY (see page 1)
7							
							(7.6) (very gradational)
					ML		SILT, with little ~~silt~~ clay TD, decreasing downward. Common plant debris and some trash (hair). Shells locally common. (Overall coarser downward for interval of 4.1 ft to 10.9 ft)
8							
		980224 "Z"	8.5				
9			9.4				
		Not Sampled					
10							10.0 (gradational)
					SM		Very fine to fine SAND with some silt, Dark gray. Dense. Silt is laminated in sand.
11							10.9 (Bottom of core)
12							

8.5 x 9.4

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SEDIMENT CORING LOG

Core Number ED-40 (core 2)

DATE SAMPLED:	8/12/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.6 - 0.2 = 5.4
TIME:	0817	% RECOVERY:	93%
UNCORRECTED DEPTH (-FT):	-54.9	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+9.6	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 56.182
ACOE WATER LEVEL (TIDE):	+10.5	LONGITUDE:	122 20 36.477
WATER DEPTH ACOE MLLW:	-44.4	NORTHING:	216052.16
VESSEL:	R/V Nancy Anne	EASTING:	1267740.30
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, Clear 65°F Calm, little wind, < 2 knots

11" = 9
6.5 - .9

* Cut off nose -0.2
* Strong petroleum odor from bottom
Saw fine angular sand in shoe - sand blast grit?

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INTERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980075				ML	(0 - 2.1 ft): Very dark gray, SILT with some sand (vf-med) and trace gravel (up to 1.0 inch), Worms near top of core (top 1.5 inches), Soft. Trace trash material. (HNu = Ø)
2.1 ft						SP	Dark gray, fine to med SAND (mostly fine), clean, except in top 3 inches is common gravel (up to 2.5 inches - difficult to extrude sample), Loose, but slightly cohesive.
3.4 ft						ML/CL	SILT with ~~some~~ clay, and plant trash material. Very dark gray, Firm.
3.7 ft							(Bottom of described core)

REVIEWED BY: ____________ PAGE 1 OF 1

SEDIMENT CORING LOG (page 1)

Core Number ED-41 (core 1)

DATE SAMPLED:	8/11/98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.9 - 0.2 = 12.7
TIME:	1414	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	42.3	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	0.4	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 59.949
ACOE WATER LEVEL (TIDE):	+1.3	LONGITUDE:	122 20 36.410
WATER DEPTH ACOE MLLW:	41.0	NORTHING:	216433.69
VESSEL:	R/V Nancy Anne	EASTING:	1267752.38
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Winds N 5-10 70°F Sunny, P.C.

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.5		980072 (comp. w/ ED#41 #2,3)			ML		(0 - 1.5 ft). SILT with little sand and trace gravel (up to 0.8 inch), sand is very fine to medium, possibly trace clay. Very dark gray, soft. Coarser downward. -with trace trash debris
1.5–4.0					ML		1.5 (1.5 - 4.0 ft): Dark Olive-gray, clean SILT. Firm. -with trace fine sand in a couple laminae. with (probable) little clay.
4.0–6.9		980073 & 980074 (Dup) (comp. w/ ED-56 #1 & ED-57 #1)	4.0		ML/SP		(4.0) (4.0-6.9 ft): ~~very~~ dark gray, sandy SILT; sand is very fine to fine (grading to medium near 6.9 ft). Overall coarsens downward. interbedded ~~and~~ intermixed. Firm to very firm, with trace whitish shells (fairly common, actually) (HNu = zero)

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DIV0440\EASTWATERWAY\CORELOG.DSF 7/24/98

SEDIMENT CORING LOG (page 2)

Core Number ED-41 (core 1)

DATE SAMPLED:	8-11-98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.7
TIME:	1414	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:	41.0	NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980073 & 980074 (Dup)			ML/SP		Sandy SILT ~~or~~ (see above) (becoming sandier in this lower zone)
		(Comp. w/ ED-56 #1 &					
7		ED-57 #1)			ML		— 6.9 ft — Dark gray, clean SILT, ~~silt~~ to Stiff, (Anu = zero)
8					ML		(8.0) — (gradational) — (8.0-12.0 ft): Dark gray SILT, with little very fine to fine sand, stiff. Sand is both interbedded and intermixed with the silt (both clean sand layers and silty sand or sandy silt). Virtually dry.
9							
10							
11		980221 "Z"	11.0				
12			12.0				12.0 — (Bottom of described core)

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11-Z
12

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SEDIMENT CORING LOG

Core Number ED-41 (core 2)

DATE SAMPLED:	8/11/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	3.0
TIME:	1109	% RECOVERY:	50%
UNCORRECTED DEPTH (-FT):	-47.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	-4.7	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 59.995
ACOE WATER LEVEL (TIDE):	5.6	LONGITUDE:	122 20 36.569
WATER DEPTH ACOE MLLW:	41.4	NORTHING:	216438.56
VESSEL:	R/V Nancy Anne	EASTING:	1267741.58
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, fog burning off, 65°F winds N <5 knots.

42" = 3.5 Nose left on.
→ Use if short of material

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980072 (comp, w/ ED-41 #1,3)			ML		(0 to 1.3 ft): Very dark gray, SILT with little fine to vf Sand, and trace gravel (up to 0.5 inch). Soft grading down to firm, trace plant + trash debris. (HNu = zero)
1							1.3 ft
					GW		DK, Olive-gray, sandy GRAVEL, gravel is up to 1.5 inches, rounded. Loose (falls apart = noncohesive), weak Petrol. odor (HNu = zero)
							1.8 ft
2			2.0		ML		(1.8 to 2.0 ft): SILT with little clay. Dark gray, firm. Little plant wood debris (HNu = zero)
							2.0 ft (Bottom of core)
3							Note: Sample material only collected from top interval (0 to 1.3 ft), and gravel was excluded.
4							
5							
6							

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SEDIMENT CORING LOG

Core Number ED-41 (core 3)

DATE SAMPLED:	8/11/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	4.3
TIME:	1126	% RECOVERY:	.722
UNCORRECTED DEPTH (-FT):	44.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+4.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 59.979
ACOE WATER LEVEL (TIDE):	+4.9	LONGITUDE:	122 20 76.393
WATER DEPTH ACOE MLLW:	39.1	NORTHING:	216436.70
VESSEL:	R/V Nancy Anne	EASTING:	1267753.61
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, P.C. 65°F winds N 5-10 knots

27" = 2.2 Core nose left on.

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980072 (comp, w/ ED-41 #1,2)			ML		(0-1.5 ft): Very dark gray SILT with little very fine to fine sand; Trace plant and trash debris and trace gravel (to 0.5 inch). Soft
1							
1.5							1.5 (gradational)
2					ML		(1.5 to ~~2.9~~ 4.3 ft): Dark olive gray, clean SILT with little clay (estimate). Firm, Trace fine sand in a couple laminae. Rounded gravel (up to 1.0 inch) in silt in upper foot.
2.9		2.9					(~~2.9~~ ft) TO
3		Not Sampled					(Note: photo says "0 to 2.9 ft" but is actually 0 to 4.3 ft)
4							
4.3							(4.3 ft) (Bottom of core) 4.3 feet
5							
6							

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SEDIMENT CORING LOG (page 1)

Core Number ED-43 (core 1)

DATE SAMPLED:	8/17/98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.5 - 0.2 = 12.3
TIME:	0930	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	42.2	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+0.8	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 35 07.445
ACOE WATER LEVEL (TIDE):	1.7	LONGITUDE:	122 20 36.592
WATER DEPTH ACOE MLLW:	40.5	NORTHING:	217193.31
VESSEL:	R/V Nancy Anne	EASTING:	1267754.81
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Mostly cloudy, sun breaks 60°F winds S 5 knots

17" = 1.4

13.9 - 1.4 =

* nose cutoff -0.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INTERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980092 (Comp. w/ ED-43 #2)			ML CL		(0 to 2.3 ft): Dark gray SILT and CLAY with trace vf sand, with little plant/wood debris, a worm tube, and shell. Soft. Wet. Sticky. (HN = zero, but not working properly at low range)
1							
2							
2.3					SP-SM		— 2.3 — Dark brown-gray SAND (fine mostly, some vF), with little silt (~10% in layers), common white and brown shells. Mod. dense.
3							
4		980093 & 980095 (F. Dup.) (comp. w/ ED-59 #1)	4.0		SM		(4.0) — (very gradational: same unit actually) Similar to above: Dark brown-gray silty SAND, sand is vf-fine, with minor plant debris. Mod dense, very firm.
5							
5.6					SP-SM		— 5.6 — (very gradational) SAND (see over)
6							

REVIEWED BY: ____________

SEDIMENT CORING LOG (page 2)

Core Number ED-43 (core 1)

DATE SAMPLED:	8-17-98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.3
TIME:	0930	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980093 & 980095 (F. Dup.) (comp. w/ ED-59 #1)			SP-SM		(5.6 - 8.4 ft): Very fine (mostly fine) to med SAND, with little silt, with common shells (white) and plant debris. Silt-rich zones occur in layers. Med. dense, Dark brown-gray. No odor.
7							
8							(8.0)
							8.4 — (gradational)
					ML		(8.4 - 12.3 ft): Dark brown-gray SILT with some vf-fine sand. Sand/silt is interbedded, laminated, and locally inter-mixed. Common plant debris. A few white shells, including a 2-inch clam shell fragment at 11 ft depth. Very firm, moist. No odor.
9							
10							
11			11.5				
		980234 "Z"					
12			12.3				(12.3) (Bottom of core)

REVIEWED BY:

SEDIMENT CORING LOG

Core Number ED-43 (core 2)

DATE SAMPLED:	8/17/98	CORE PENETRATION:	6.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	6.5
TIME:	0905	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	-42.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+0.1	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 35 07.468
ACOE WATER LEVEL (TIDE):	1.0	LONGITUDE:	122 20 36.363
WATER DEPTH ACOE MLLW:	-41.0	NORTHING:	217195 33
VESSEL:	R/V Nancy Anne	EASTING:	1267770.55
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Mostly cloudy, sun breaks 55°F winds ≤5 knots

* Cut to 4'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980092 (comp. w/ ED-43#1)			ML/CL		(0 to 2.8ft). Dark gray SILT and CLAY, with trace vf sand (in layers), Soft, Sticky, wet, with little plant debris. No noticeable odor.
1							
2							
2.8							Silty, vf-fine SAND, with abundant white shells, well-laminated silt/sand interbeds. Mod. dense, very firm. Dark brown-gray.
3					SM		
4			4.0				(4.0) (Bottom of Core)
5							
6							

REVIEWED BY: ______

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SAIC

SEDIMENT CORING LOG

Core Number ED-44 (core 1) (1 of 2)

DATE SAMPLED:	8/19/98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.9 - 0.2 = 12.7
TIME:	1144	% RECOVERY:	100%.
UNCORRECTED DEPTH (-FT):	45.3	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+1.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 35 10.445
ACOE WATER LEVEL (TIDE):	+1.9	LONGITUDE:	122 20 36.337
WATER DEPTH ACOE MLLW:	43.4	NORTHING:	217496.88
VESSEL:	R/V Nancy Anne	EASTING:	1267778.25
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	clear, sunny wind 10 knots N. 1/2 foot chop.

1' 13.9 - 1 * Cutoff nose -0.2'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1		980107				ML	SILT, with trace clay and v. fine sand, trace twigs (1-2" long) and trace shell fragments, trace hair fibers. very soft and slightly firm @ 1-1.5' grayish brown. wet. no odor.
2						ML/CL	clayey SILT OR SILTY CLAY, very soft & very sticky. uniform gray in color. wet.
2–3						ML	SILT, with trace clay and fine sand with some shell fragments, wood debris and twigs throughout interval. firm and wet. gray to brownish gray. Sheen on water
3–4						ML/SP	SILT with lots of fine sand and trace fragments of shells. sandy silt. firm and moist.
4–6		980110			SP-SM	~~SM~~	SAND, fine to medium, with ~~some~~ little silt and trace rootlets. med dense, moist, homogenous texture. d. brown

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SEDIMENT CORING LOG

Core Number ED-44-1 (2 of 2)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
		~~980107~~ 980110			SP-SM		SAND, as above	
					SP-SM			
7								
8							~~END OF CORE SECTION~~	
					SP-SM		SAND, as above	
		Archive			SM/ML		8.6' contact SAND, fine with silt and trace clay interbedded with SILT and trace clay and trace rootlets, moist dense. d. grayish brown.	8.6
9		"Z" 980244						
		Not sampled			SM		SAND, fine with some silt and trace rootlets, moist dense ~~[illegible]~~, d. brown.	9.5
10								
					SM/ML		SAND, fine with silt and trace clay interbedded with silt and trace clay, trace rootlets layers. dense d. grayish brwn. moist	10.4
11					ML/CL		SILT w/ clay and trace f. sand, very sticky, v. firm high plasticity. moist d. grayish brown	
					SM/ML		SAND, fine to medium with some ~~silt~~ silt interbedded w/ SILT and little ~~trace~~ clay, rootlet layers. to 12.7' d. grayish brown, moist dense.	11.4
12								12

12.7 BOTTOM OF CORE

REVIEWED BY: ______ PAGE 2 OF 2

SEDIMENT CORING LOG

Core Number ED-44 (core 2)

DATE SAMPLED:	8/19/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	6.1
TIME:	0933	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	-42.6	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	-0.9	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 35 10.385
ACOE WATER LEVEL (TIDE):	0.0	LONGITUDE:	122 20 36.370
WATER DEPTH ACOE MLLW:	-42.6	NORTHING:	217490.84
VESSEL:	R/V Nancy Anne	EASTING:	1267775.87
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny clear, 60°F winds N 5-8 knots

5" = 0.4

* was cut to 4'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0–2.3		980107 (0–4 ft)				ML	SILT, with ? little trace clay, and trace v. fine sand. little to trace rootlets and hair fibers throughout. soft & wet. sheen on water. strong H_2S odor. gray to brownish gray.
2.3–2.9						ML	2.3 SILT, with trace? clay and fine sand, some twigs and shell fragments throuout. wet firm gray
2.9–3.8						ML/SP	SILT, with some fine sand, and trace? clay and some woody debris and scrap metal. moist and firm. brownish gray to brown.
3.8							3.8 (should be 4 ft - cut to that - may have scrunched upon extrusion)

Depth scale: 1, 2, 3, 4, 5, 6

REVIEWED BY: ____________

SEDIMENT CORING LOG

SAIC

Core Number ED-45 (core 1) (1 of 3)

DATE SAMPLED:	8/19/98	CORE PENETRATION:	16.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	15.4 - 0.2 = 15.2
TIME:	1116	% RECOVERY:	96%
UNCORRECTED DEPTH (-FT):	38.3	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+0.3	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 35 13.081
ACOE WATER LEVEL (TIDE):	+1.2	LONGITUDE:	122 20 36.037
WATER DEPTH ACOE MLLW:	37.1	NORTHING:	217763.51
VESSEL:	R/V Nancy Anne	EASTING:	1267804.05
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear, 60°F wind N 5-8 knots

30" = 2.5 * Cut off nose - 0.2'

17.9 - 2.5 = 15.4

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980106				ML/CL	Clayey SILT, with trace v.fine sand, trace rootlets olive gray, soft to ~~firm~~ firm 0-0.9', very moist to wet, moderate H_2S odor. ~~sheen~~ sheen on standing water. sticky.
1						ML/CL	clayey SILT, with trace v.fine sand & trace rootlet and hair fiber. woodey debris layers olive gray brown. firm. very moist to wet sheen on surface water. moderate H_2S odor. increase in sand 2.8
3						ML	SILT, with little clay and little v.fine sand. trace rootlets, firm to dense. homogenous texture. brownish gray. very moist to wet... moderate to slight H_2S odor
						ML/[illegible]	~~END OF CORE~~
4		980110				ML	SILT as above
						OL	HIGHLY ORGANIC, TWIGS, leaves into fine silty SAND matrix 4.3
						ML/CL SM	SILT w/ CLAY and trace f sand interbedded with fine silty clayey SAND dense to firm, moldable in silt clay layers, dense SAND. d. grayish brown moist 4.5
5						SM	SAND, fine with some silt and trace rootlets d. grayish brown. 5.4
6							

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SEDIMENT CORING LOG

Core Number ED-45 (core 1) (2 of 3)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE				
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS	
6		980110				SM	SAND, as above	no odor	
7						ML/CL SM	SILT and SAND interbedded, as described from 4.5 to 5.4 no odor trace shell fragments.		7.1
8						SM/ML	~~SILT~~ SAND, fine with silt with the interbedded SILT containing clay? and trace rootlets. very hard, dense, moist d. grayish brown grades into more silty and clayey fine sand. no odor		7.8
9									
10						ML/CL SM	SILTY CLAYEY SAND to SANDY CLAYEY SILT very poorly sorted "Till Like" very hard. moist v.d. ~~grayish~~ brown to gray brown.		9.1
11									
12									

SEDIMENT CORING LOG

Core Number ED-45-core 1 (3 of 3)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
		98011O				SM	SILTY CLAYEY SAND, as above	
13						SM/ML	SAND, fine with silt and claye interbedded w/ thin stringers to laminated silt with clay and trace rootlets thruout. moist. dense to hard	
14		archive "Z"						
		980245						14.5
15								
16								
5								
6								

SEDIMENT CORING LOG

Core Number ED-45 (core 2)

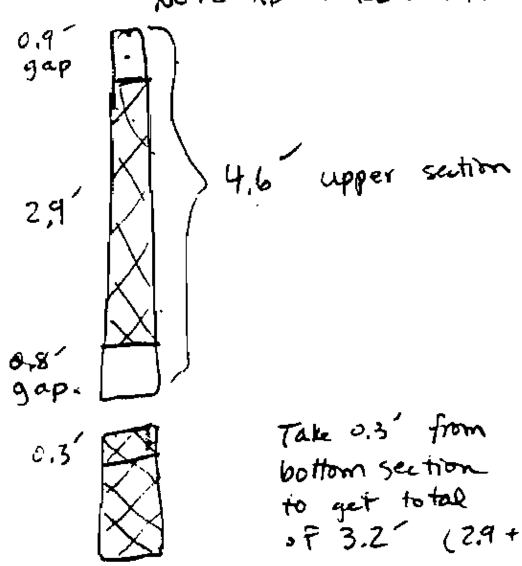
DATE SAMPLED:	8/19/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	~~5.8~~ 4.8
TIME:	0957	% RECOVERY:	~~93%~~ 80%
UNCORRECTED DEPTH (-FT):	38.8	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	-1.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 75 13.106
ACOE WATER LEVEL (TIDE):	-0.1	LONGITUDE:	122 20 36.113
WATER DEPTH ACOE MLLW:	~~-38.9~~ -38.9	NORTHING:	217766.15
VESSEL:	R/V Nancy Anne	EASTING:	1267798.90
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, calm, clear, 60°F winds N 5 knots

11" = 0.9
6.5 - 0.9 = 5.6
* gap - 0.8 = 4.8

~~93% of 4 = 3.7~~
80% of 4 = 3.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–3.2		980106				ML/CL	clayey SILT with trace hairs rootlets and angular fine gravel. soft from 0' to 2'. firm 2-3.7' very moist to wet. sticky, moldable olive-gray brown. very strong H_2S odor. 1.2 trace sand begins 1.2' to 3.2'
3.2							

NOTE ABOUT RECOVERY:



Take 0.3' from bottom section to get total of 3.2' (2.9 + 0.3)

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SEDIMENT CORING LOG

SAIC

Core Number ED-46 (core 1)

DATE SAMPLED:	5/5/98	CORE PENETRATION:	6.5'
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	4.9' - 0.2 = 4.7
TIME:	0857	% RECOVERY:	75%
UNCORRECTED DEPTH (-FT):	48.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	0.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 30.830
ACOE WATER LEVEL (TIDE):	0.9	LONGITUDE:	122 20 34.982
WATER DEPTH ACOE MLLW:	47.1	NORTHING:	213481.89
VESSEL:	R/V Nancy Anne	EASTING:	1267792.38
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	PC, calm, 65-70F

9' *C + soft core nose -0.2'

13.9 - 9 = 4.9

gravels @ bottom (nose)

Shell debris @ surface

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INTERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
0–2.8		980049 (comp. w/ ED-46#2)			ML		(0 to 2.8 ft) Very dark gray SILT with some clay and trace fine sand. Worms (+ tube worms) at top few inches. Trash/hair debris common. Soft. Rare small white shell fragments. HNu = zero (everywhere)	
2.8			3.0		SP		(2.8) (sharp contact) Dark olive-gray, fine to medium SAND. Clean sand, ~Med. dense. Becoming coarser downward grading to fine to coarse sand.	
		980209 "Z"	3.7		SW			
4.2			4.4		SW		4.2 Dark olive-gray, fine to coarse gravelly SAND, ~~with~~ with gravel up to 3 inches, angular & rounded.	
4.7		not sampled					4.7 (bottom of core)	

Depth scale: 1, 2, 3, 4, 5, 6

3.7
4.4

SEDIMENT CORING LOG

Core Number SD-46 (core 2)

DATE SAMPLED:	3/5/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	4.7 - .2 = 4.5
TIME:	1645	% RECOVERY:	75%
UNCORRECTED DEPTH (-FT):	49.5	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	- 0.1	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 30.812
ACOE WATER LEVEL (TIDE):	+0.8	LONGITUDE:	122 20 35.172
WATER DEPTH ACOE MLLW:	48.7	NORTHING:	213480.32
VESSEL:	R/V Nancy Anne	EASTING:	1267779.32
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	P.C. 65-70°F, calm winds light <5 knots S.

22" >1.8

6.5 - 1.8 = 4.7

* Cut off core nose - 0.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980049			ML		(0 to 1.1 ft): Very dark gray SILT with some clay, sticky, soft, trace hair debris.
1					SW		—1.1— (1.1 to 3.3 ft): gravelly, fine to coarse SAND. Gravel is up to 3 inches, rounded, larger in upper half of interval.
2							
		not Sampled					
3					SW		3.3 ft (Bottom of described core)
4							
5							
6							

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SEDIMENT CORING LOG

Core Number ED-48 (core 1)

DATE SAMPLED:	8/20/98	CORE PENETRATION:	6
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	4.25 − 0.2 = 4.0
TIME:	0912	% RECOVERY:	71%.
UNCORRECTED DEPTH (-FT):	~~53.2~~ 49.2	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	0.3	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 38.084
ACOE WATER LEVEL (TIDE):	1.2	LONGITUDE:	122 20 35.224
WATER DEPTH ACOE MLLW:	48	NORTHING:	214217.08
VESSEL:	R/V Nancy Anne	EASTING:	1267790.21
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear, 60°F calm winds light N <5 knots

27 ÷ 12 = 2.25 cutoff nose -0.2'

Note location in front of large storm outfall
Heavy PAH odor from nose, sulfide from surface

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1		980114				SM	SAND; fine to medium with silt and "needle like" wood debris, rootlets (trace), trace subrounded fine gravel. loose to dense, ~~wet to~~ moist to slightly wet. Shell fragments, black, strong petroleum and H_2S odor.
1–2.2						SM	grades into SAND, fine with more silt and clay? SAND, fine with silt & clay? twigs, rootlets and hair trace angular fine gravel. black very moist to wet strong petroleum odor. moldable ~~with~~ when pinch ~~between~~ fingers.
2.2–3						CH/ML	CLAY with some silt and little f. sand. trace shell fragments and hair fibers. plastic black, soft. moist strong petro. odor.
3–3.8		Not Sampled				ML/SM	SILT, with some fine sand ~~and~~; clay?, little hair fibers, black, moist to wet. soft. strong petroleum odor.
4							
5							
6							

Right margin: 3, 2., 3, 3.

REVIEWED BY: ______________ PAGE 1 OF 1

SEDIMENT CORING LOG

SAIC

Core Number ED-48 (core 4)

DATE SAMPLED:	8/20/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.3 -0.2 = 5.1
TIME:	1020	% RECOVERY:	88%
UNCORRECTED DEPTH (-FT):	~~48~~ 47.6	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	-0.9	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 38.055
ACOE WATER LEVEL (TIDE):	0.0	LONGITUDE:	122 20 35.276
WATER DEPTH ACOE MLLW:	47.6	NORTHING:	214214 21
VESSEL:	R/V Nancy Anne	EASTING:	1267786.59
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear, 65°F 60 - winds light N <5

14 ÷ 12 = 1.2

Cut off nose -0.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–0.5		980114				ML	SILT with clay and v.f. sand with little twigs and shell fragment very soft strong petroleum odor. black
0.5–1					SP-SM		SAND; fine with little silt, shell fragments and twigs, strong petroleum odor. moist (0.)
1.5–3.5						SM	increase in silts and clay? and fine ~~gravel~~ angular gravel (?) slightly moldable when pinch between fingers., soft, strong petroleum odor. black. hair fibers in this section of core
3.5–4						SM	SAND, fine to medium, black, strong petro odor. moist, similar to sand described above.
4–4.5		archive "Z"					
4.5–5		980248 Not Sampled					(5.)
5–6							

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SEDIMENT CORING LOG

Core Number ED-48 (cores)

DATE SAMPLED:	8/20/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.1 - 0.2 = 4.9
TIME:	1043	% RECOVERY:	85%
UNCORRECTED DEPTH (-FT):	48.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	-0.9	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 38.049
ACOE WATER LEVEL (TIDE):	0	LONGITUDE:	122 20 35.734
WATER DEPTH ACOE MLLW:	48.0	NORTHING:	214213.68
VESSEL:	R/V Nancy Anne	EASTING:	1267782.60
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Clear sunny, 60-65°F winds light N 2-3 knots

12 = 1.4

Cut off nose -0.2'

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS	
		980114				ML/CL	SILT, with some to little clay, very soft; wet, trace rootlets. strong H_2S odor, wet. v.d. olive gray to black. trace v.f. sand.	0.6
1						SM	SAND with some silt and little clay? and ~~trace~~ rootlets, hair fibers, and trace shell ~~fragments~~ fragments thruout. wet soft v.d. olive gray to black strong H_2S odor	1.6
2						ML/	SILT, with some sand and clay. trace hair, twigs fibers. strong petroleum ~~odor~~ odor. moldable, wet, soft v.d. olive gray.	2.2
3						SM/ML	SAND, with some silt; little clay rootlets hair, woody debris, soft, wet v.d. olive gray to black, strong petroleum odor.	3.4
4								
5								
6								

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SEDIMENT CORING LOG (page 1)

Core Number ED-50 (core 1)

DATE SAMPLED:	8/13/98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.7 - 0.2 = 12.5
TIME:	1434	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	48.4	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+ 3.5	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 43.445
ACOE WATER LEVEL (TIDE):	+4.4	LONGITUDE:	122 20 35.339
WATER DEPTH ACOE MLLW:	44.0	NORTHING:	214780.58
VESSEL:	R/V Nancy Anne	EASTING:	1267793.38
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear 80°F winds N/NW 5-10 knots

14" = 1.2

13.9 - 1.2 = 12.7

* Cut off nose -02

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980090 (comp. w/ ED-50 #2)			NL/CL		(0 to 2.3 ft): SILT and CLAY, with trace vf sand. With plant debris, V. Dark gray. Soft. Wet.
1							
2							
2.3					SM		Dark gray fine to vfine SAND with some silt, Common plant/wood debris, and hair. Loose to mod. Dense. Shell fragments present. Wood is up to 2 inches
3							
4			4.0				
(4.0)		980091 (comp. w/ ED-36 #1)			SP		(Same as above, with less silt)
4.4					ML		SILT, with one interbed of vf sand at 5.2 to 5.5 ft. Stiff. Massive. Dark brown-gray. Very moist. Some small white shells.
5							
6							

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SEDIMENT CORING LOG (page 2)

Core Number ED-50 (core 1)

DATE SAMPLED:	8-13-98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.5
TIME:	1434	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY	OBSERVATIONS
6		980091 (comp. w/ ED-36 #1)			ML			
7								
8			8.0				(8.0)	
		980233 "Z"			ML		Similar to above; SILT with some interbeds of sand and silty sand between 8.2 & 9.0 ft depth. Sand is mostly vf, some fine. Laminated silt, some small white shells, Stiff, Dark brown-gray, Moist.	
9			9.0					
		Not Sampled						
10								
11								
12							12.5 (Bottom of boring at 12.5 ft)	

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SEDIMENT CORING LOG

Core Number ED-50 (core 2)

DATE SAMPLED:	8/13/98	CORE PENETRATION:	60
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.7
TIME:	1323	% RECOVERY:	95%
UNCORRECTED DEPTH (-FT):	49.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	5.3	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 43.603
ACOE WATER LEVEL (TIDE):	6.2	LONGITUDE:	122 20 35.209
WATER DEPTH ACOE MLLW:	42.8	NORTHING:	214776.15
VESSEL:	R/V Nancy Anne	EASTING:	1267802.21
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny clear 75-80°F winds N 5-10 knots.

6.0 - 0.8   6.5 - 0.8   * cut to 3.8

4 × 95% = 3.8

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980090 (comp. w/ ED-50 #1)			ML/CL		(0 to 1.5 ft): SILT and CLAY, with trace vf sand. Very dark gray, soft, wet. (HNu = zero (unreliable results)
1							
1.5					SM		Silty, fine to vf SAND, with common plant debris and hair debris and shells. Mod. dense, firm. ~~Very~~ Dark gray. (HNu = zero; unreliable results)
2							
3							
3.8			3.8				(Bottom of core)
4							
5							
6							

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SEDIMENT CORING LOG (page 1)

Core Number ED-53 (core 1)

DATE SAMPLED:	5/12/98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.7 - 0.2 = 11.5
TIME:	1309	% RECOVERY:	98%
UNCORRECTED DEPTH (-FT):	52.5	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	7.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 50.829
ACOE WATER LEVEL (TIDE):	7.9	LONGITUDE:	122 20 35.398
WATER DEPTH ACOE MLLW:	44.6	NORTHING:	215503.43
VESSEL:	R/V Nancy Anne	EASTING:	1267805.62
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny clear winds N 5-10 70°F

27" = 2.25
139 - 2.25 = 11.7
* Cut off nose - 0.2'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–0.9		980079 (comp. w/ ED-53#2)			ML		(0 to 0.9 ft): SILT with some clay; very dark gray with some medium brown color, some plant material and possible trash (hair), wet soft
0.9–3.9					ML		-0.9 (0.9 to 3.9 ft): Dark brown-gray clean SILT, with trace intermixed vf sand. Massive. Firm grading down to stiff. Very moist.
3.9–6		~~ED-53~~ 980080 (comp. w/ ED-39#1)	3.9		ML		(3.9) (3.9 to 7.9 ft): (Same SILT as above) with vf-fn sand only in upper 1.0 ft (down to ~5 ft depth). Firm to stiff.

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SEDIMENT CORING LOG (page 2)

Core Number ED-53 (core 1)

DATE SAMPLED:	8-12-98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.5
TIME:	1009	% RECOVERY:	98%
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
		980050 (comp. w/ ED-39 #1)			ML		(3.9–7.9): SILT (see above)
7		980225 "Z"	7.3				
							–7.9 (gradational)
8			8.2		ML/SP		Sandy SILT, sand is very fine to fine, interbedded and intermixed with silt, Very firm, Moist. Dark brown-gray. Trace/rare plant material. No odor.
		Not sampled					
9							
10							
11							–11.5 (Bottom of core)
12							

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SEDIMENT CORING LOG

Core Number ED-53 (core 2)

DATE SAMPLED:	8/12/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.5 - 0.2 = 5.3
TIME:	0940	% RECOVERY:	92%
UNCORRECTED DEPTH (-FT):	53.1	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+9.2	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 50.875
ACOE WATER LEVEL (TIDE):	+10.1	LONGITUDE:	122 20 35.334
WATER DEPTH ACOE MLLW:	43.0	NORTHING:	215513.01
VESSEL:	R/V Nancy Anne	EASTING:	1267808.10
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, Clear 65-70°F Calm winds N <5 Knots

1'
5.5 - 1 = 5.5

Cutoff nose -0.2'
silty F. Sand in nose.

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980079 (Comp. w/ ED-53 #1)			~~SP-SM~~ ML		0 to 0.9 ft: SILT, with little clay, and little vf Sand. Soft. wet. Very dark gray. trace plant material. H_2S odor (H_2S = zero, HNu = zero)
0.9							0.9
1					ML		(0.9-3.7): SILT, with trace (<1%) vf Sand, Massive, clean silt. Dark brown-gray. Firm to very firm. (HNu = zero, no odor, H_2S = zero)
2							
3							
3.7			3.7				(3.7) (Bottom of described core)
4							
5							
6							

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SEDIMENT CORING LOG (page 1)

Core Number ED-54 (cont.)

DATE SAMPLED:	8/11/98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.6 - 1 = 10.6
TIME:	0834	% RECOVERY:	97%
UNCORRECTED DEPTH (-FT):	55.2 (56.4' closer to dock)	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+9.6	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 53.713
ACOE WATER LEVEL (TIDE):	10.5	LONGITUDE:	122 20 35.340
WATER DEPTH ACOE MLLW:	44.7	NORTHING:	215800.52
VESSEL:	R/V Nancy Anne	EASTING:	1267813.33
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny P.C 65°F winds light N, 2-3 knots.

28" = 2.3
13.9 - 2.3 = 11.6

Note: lost 1 ft material from bottom. Cut off 1 ft from bottom

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.2		980069				ML	SILT, with trace v. fine sand and little clay and rootlets throughout, v. soft and somewhat sticky. wet. sheen on standing water, black H_2S odor. 5ppm on Hnu sustained reading.
1.2–2.6						SM	1.2 — grades into very silty SAND (fine) w/ trace amounts of fine angular gravel, pulverized shells, hair, rootlets, loose black, wet, strong petroleum odor 5ppm on Hnu - sustained. large ~~flat~~ flat wood debris @ 2.2' bgs.
2.6–3.9						SM/CL	Highly organic silty sand mixture, lots of small rootlets, hair, twigs 1-2" long, and trace rounded fine gravels. strong petroleum smell 10ppm after core was opened, black wet.
3.9–6		980068				SM/ML	3.9 — SILTY SANDY MIXTURE w/ lots of woody fibers twigs (1-2" long) plastic coated wire, slight petroleum odor in the top 0.2' of sample. v.d. gray to black. round csc gravels (little) zone @ 4.2' bgs
						SM	grades into uniform silty SAND, fine ~~[illegible]~~ grayish brown. moist dense to loose MOIST no odor, no visible contamination,

Depth scale: 1, 2, 3, 4, 5, 6. Right margin: 1.2, 2.6, 3.9, 6.0

REVIEWED BY: ______

DIV0440\EASTWATERWAY\CORELOG.DSF 7/24/98

SEDIMENT CORING LOG (page 2)

Core Number ED-54 (core 1)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
		980068				SM	SAND, fine with some silt, moist homogeneous uniform texture. dense gray brown. no visible contamination, no odor.	
7		Z archive						
		980220						
8							7.9	
		Not Sampled						
9							8.9	
4								
5								
6								

REVIEWED BY: ______

SEDIMENT CORING LOG

Core Number SD-54 (core 3)

DATE SAMPLED:	8/11/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.6 - 0.3 = 5.3
TIME:	0932	% RECOVERY:	93%
UNCORRECTED DEPTH (-FT):	53.8	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	8.1	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 53.453
ACOE WATER LEVEL (TIDE):	+9.0	LONGITUDE:	122 20 35.295
WATER DEPTH ACOE MLLW:	44.8	NORTHING:	215774.12
VESSEL:	R/V Nancy Anne	EASTING:	1267815.39
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, Fog rolling in. 65°F winds N-5 knots

6.5 - 0.9 = 5.6 * Cutoff nose - 0.3'

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.1		980069				ML	SILT with v. fine sand and trace rootlets and hair fiber. one large cobble 3" wide @ 0.5' bgs wet. soft, black, sheen on water. strong H_2S smell, 25ppm when core opened.
1.1–2						SM	grades into SAND, fine with some silt, trace fine subround opaque gravels, trace med. sand med. dense and little rootlets, wet. strong H_2S odor. poorly sorted. (sheen on water)
2–3.9						SM	SAND, v. fine to fine with lots of silt, gray brown homogeneous texture. slight H_2S odor. no visible contamination, moist. hard to very dense.
3.9							

Depth scale: 1, 2, 3, 4, 5, 6

SEDIMENT CORING LOG

Core Number ED-58 (core 1) (1 of 2)

DATE SAMPLED:	8/25/98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	12.3 - 0.2 = 12.1
TIME:	0808	% RECOVERY:	98%
UNCORRECTED DEPTH (-FT):	53.5	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	9.4	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 35 03.577
ACOE WATER LEVEL (TIDE):	10.3	LONGITUDE:	122 20 35.396
WATER DEPTH ACOE MLLW:	43.2	NORTHING:	216779.85
VESSEL:	R/V Nancy Anne	EASTING:	1268221.09
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny clear, 55-60°F winds ~ 4 knots.

Note: some gravels; wood debris, silt got over piston, estimate ~2 inches of surface lost.
19" = 1.6 13.9 - 1.6 * Cut off nose - 0.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.5		980130				SM	SAND, fine with silt and ~~little~~ little rootlets trace csc sand. crushed shell fragment, trace subrounded csc grvl and cobbles. loose and slough. poorly sorted d. grayish brwn. wet.
1.5–4		↓				SM	SAND, ~~f~~ fine with some silt, contains ~~fewer shells~~ no shells fragments, trace subrounded grvls and large highly oxidized wood chips (orange surface coatings) (3-4' elongate & flat.) moist, H₂S odor slight. hard to v. dense. d. gray brwn.
4–4.5		980131				SM	END OF CORE SEG. 0N SAND; as above
4.5–6		↓				ML	SILT with stringers of v. fine sand
							~~silt~~ silt with increasing amount of fine sand. (trace to little sand)

Right margin: 1.5, 4.5, 6.1

REVIEWED BY: ______ PAGE 1 OF 2

SEDIMENT CORING LOG

Core Number SD-58-1 (2 of 2)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE		
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
		980131				ML/SM	SILT, with v. fine sand (trace to little) v. stiff. v. dark gray brown moist no odor.
7							
8						ML/SM	7.9 SILT, with v. fine SAND (little) v. d. gray brown. no odor
		archive					
9		"Z" 980255					
		Not Sampled					
10							
11							
12							11.9 feet · Bottom of Core

REVIEWED BY: ______

may have pile drived
Surface may be more than 77%
look at material
out to 4 ft

SEDIMENT CORING LOG

Core Number ED-58 (core 2)

DATE SAMPLED:	8/25/98	CORE PENETRATION:	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	9.2
TIME:	0849	% RECOVERY:	77%
UNCORRECTED DEPTH (-FT):	53.6	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	~~9.4~~ 9.4	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 35 03.592
ACOE WATER LEVEL (TIDE):	10.3	LONGITUDE:	122 20 35.427
WATER DEPTH ACOE MLLW:	43.3	NORTHING:	216801.42
VESSEL:	R/V Nancy Anne	EASTING:	1267827.00
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny clear, 60°F winds light N < 2 knots.

57" = 4.75'

13.9 - 4.75 = 9.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980130			SP-SM		SAND, med. to fine with trace to little silt trace to little csc sand and trace rootlets. trace rounded csc gravel. with ~~trace~~ grayish brown. dense v. moist. no odor
1.5						SM	SAND fine with some silt with trace amounts of twigs (1-2" long) and trace shell fragments. grayish brown. dense moist no odor
						SM/ML	stringers of silt interbedded within SAND.
4							
5							
6							

REVIEWED BY: ____________ PAGE 1 OF 1

SEDIMENT CORING LOG

Core Number ED-58 (3)

DATE SAMPLED:	8/26/98	CORE PENETRATION:	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.8 -0.2 = 5.6
TIME:	1438	% RECOVERY:	97%
UNCORRECTED DEPTH (-FT):	44.8	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+2.7	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 35 03.453
ACOE WATER LEVEL (TIDE):	+3.6	LONGITUDE:	122 20 35.641
WATER DEPTH ACOE MLLW:	41.2	NORTHING:	216787.62
VESSEL:	R/V Nancy Anne	EASTING:	1267812.06
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	P.C. sun breaks 65-70°F calm, winds light N 2 knots

9" = 0.75
6.5 - 0.75 = 5.8

* C-toff nose -0.2

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–0.4		980130				ML	SILT, with lots of f. v. sand, very soft, wet black, trace black wet
0.4–2.0						SM	grades into SAND; with some silt, lots of woody debris and twigs and small shell fragments rootlets loose to dense d. gray brown wet
2.0–3.9						SM/ML	grades into SAND ~~of~~ to fine w/ lots of silt, hair fibers, interbedded with silt and clay d. graybrown soft strong H2S smell. wet.
3.9							

Depth scale: 1, 2, 3, 4, 5, 6

REVIEWED BY: ______

PAGE 1 OF 1

SEDIMENT CORING LOG

Core Number ED-62

DATE SAMPLED:	2/29/98	CORE PENETRATION:	16.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	16.2
TIME:	1403	% RECOVERY:	98%
UNCORRECTED DEPTH (-FT):	-42.2	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+3.9	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 37.565
ACOE WATER LEVEL (TIDE):	+4.8	LONGITUDE:	122 20 42.832
WATER DEPTH ACOE MLLW:	-37.4	NORTHING:	214174.74
VESSEL:	R/V Nancy Anne	EASTING:	1267267.66
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	P.C. Sunny 70-80°F wind 5-10 knots N.

~~Fine sand in nose~~

~~22 = 1.6~~
~~17.4 to 16.2~~

Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INTERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.0		~~IBT?~~ ~~STUDY?~~			ML		Black SILT with strong H_2S odor. Soft. HNu reads up to 35 ppm on sample. H_2S = zero. (mostly lower half) Wet.
1.0							1.0 — (grades rapidly)
1.0–3.9		980015			ML		Medium to dark gray SILT, with occasional trash debris (hair, trash) and plant debris. Firm grading down to stiff. Mild H_2S and fuel odor. HNu is up to 1ppm. Moist to v. moist.
3.9							3.9
3.9–6		980016			ML		Dark gray SILT, with little very fine to fine sand, and trace clay. Some laminations. Firm to very firm. Moist. Weak H_2S odor.

(to 8.0)

REVIEWED BY: ____________

ED-62

SEDIMENT CORING LOG

Core Number ED-62 (page 2)

DATE SAMPLED:		CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
6		980016			ML			
1 7								
2 8							8.0	
					ML/SM		Dark gray to dark brown-gray Sand & silt interbedded, with little clay, Laminated layers of silt, sand, silt/sand mixes, and clay. Firm to very firm. Moist. No noticeable odor. Sand is mostly fine (to very fine).	
3 9								
4 10								
5 11								
6 12							12.0	

REVIEWED BY: ____________

SEDIMENT CORING LOG

Core Number ED-62 (page 3)

DATE SAMPLED:	7-29-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
12		980016			ML/SP		12.0 Dark gray-brown Sandy SILT, with little clay. Sand is almost all very fine - close to silt/sand boundary. Clay is only present at 14.5 to 14.8'. A few clean sand lenses near base (vf-f sand). Very firm to stiff. Moist. No odor. Wet at top of core.
1	13						
2	14		14.3				
		Archive "Z"					
3	15	980017					
		discard					
4	16						16.0' - end of core
5							
6							

SEDIMENT CORING LOG

Core Number ED-63

DATE SAMPLED:	7/29/98	CORE PENETRATION:	16.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	15.4
TIME:	1428	% RECOVERY:	93%
UNCORRECTED DEPTH (-FT):	-43.0	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+3.2	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 38.482
ACOE WATER LEVEL (TIDE):	+4.1	LONGITUDE:	122 20 42.681
WATER DEPTH ACOE MLLW:	-38.9	NORTHING:	214265.41
VESSEL:	R/V Nancy Anne	EASTING:	1267279.79
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	P.C. Sunny, 70-80°F Winds N 5-10 knots

30 in ÷ 12 = 2.5
17.9 - 2.5 = 15.4

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.4					ML		Dark gray SILT, clean, with mild H_2S odor. HNu up to ~1.0 ppm, No trash or plant material, Soft, wet.
1.4							-1.4' — — (grades rapidly) — — —
1.4–3.7					ML		Medium to dark gray (or dk olive gray) SILT with trace clay and little very fine sand. Firm grading down to ~~stiff~~ very firm TD Moist to very moist
3.7		980020	3.7				-3.7'
3.7–6		980020			ML		(3.7-7.7) Dark gray SILT with some clay and little very fine to fine sand, No odor, Firm, Moist. (HNu = Ø ppm)

REVIEWED BY: ____________

ED-63

SEDIMENT CORING LOG

Core Number ED-63 (page 2)

DATE SAMPLED:	7-29-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
6		980020			ML		SILT (as above)
7							
8							7.7'
9					SM		8.2 Dark gray Silty SAND. Sand is very fine to fine. Laminated and interbedded. Firm grading down to stiff. Moist. No odor. Generally coarser downward (silt → sand)
10							
11							11.7 (gradational)
12		980021	12.2		ML/SP		Sandy SILT. Sand is very fine to fine. Same unit as above but more silt than sand
13			13.1				
14							
15							15.4 - (bottom of core)

REVIEWED BY: ______

DIV0440\EASTWATERWAYCORELOG.DSF 7/24/98

SEDIMENT CORING LOG (core 1)

Core Number ED-70 (extra 6' for contaminant (ow))

DATE SAMPLED:	7/29/98	CORE PENETRATION:	6'
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	5.5
TIME:	1614	% RECOVERY:	92%
UNCORRECTED DEPTH (-FT):	42.8	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	3.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 ~~39~~ 43.116
ACOE WATER LEVEL (TIDE):	3.9	LONGITUDE:	122 20 39.291
WATER DEPTH ACOE MLLW:	38.9	NORTHING:	214232.31
VESSEL:	R/V Nancy Anne	EASTING:	1267521.43
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

6.5
12"

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
0–3.4'		980000			SM		Black Silty SAND. Sand is very fine to medium. Abundant trash and organic debris (hair, trash, plant matter). Strong fuel and H_2S odor. (background readings on H_2S meter; up to 35 ppm on HNu; highest near top, decreasing downward).	
3.4'							— 3.4' —	

Depth scale: 1, 2, 3, 3.4', 4, 5, 6

REVIEWED BY: ______ PAGE ___ OF ___

SEDIMENT CORING LOG (core 2) (page 1)

Core Number ED70

DATE SAMPLED:	7/28/98	CORE PENETRATION:	16.5'
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	14.8'
TIME:	12:26	% RECOVERY:	90%
UNCORRECTED DEPTH (-FT):	-43.6	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+4.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 43.159
ACOE WATER LEVEL (TIDE):	+4.9	LONGITUDE:	122 20 39.429
WATER DEPTH ACOE MLLW:	-38.7	NORTHING:	214736.75
VESSEL:	R/V Nancy Anne	EASTING:	1267512.06
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

38" Shell piece at core nose, native?

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
		980000				SP	top 2 in med. sand with some silt
1						ML	after 2 in silt with fine sand with ~~veo~~ organic debris hair, some variable amounts of sand through (sandy silt)
2							H_2S odor - strong black
3							3.4 ft
3.6						ML/CL	becomes more of a silt with clay to the end no organics clean break from the organic layer
4		980004				ML	some fine sand lenses throughout primarily silt with some layers of fine sands and clay
5							
6							H_2S odor very weak gray to olive gray
7							sand content inc at depth, but still a silt
						ML/CL	7.4 silt with clay dark gray occasional lense of organics (sparse no odor
8							grades to silt with some fine sand coarser zones with sand dark olive gray
9						ML	silt with some fine sand

REVIEWED BY: ____________

DIV0440\EASTWATERWAY\CORELOG.DSF 7/24/98

SEDIMENT CORING LOG (page 2)

Core Number ED70

DATE SAMPLED:	7/28/98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
		980004						
10								
11		~~[illegible]~~					11.1 ft silty sand (fine sand)	olive gray brown (slight olive)
12		980007 Archive Z	12.9				12 ft becomes more of a sandy silt	
13		discard					clean silt	
14							14.1 ft bottom of core	

REVIEWED BY:

Incorrectly Sampled

SEDIMENT CORING LOG

Core Number ED-75

DATE SAMPLED:	7/28/98	CORE PENETRATION:	12.5'
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	9.8'
TIME:	0759	% RECOVERY:	78%
UNCORRECTED DEPTH (-FT):	~~51.2~~ 51.2'	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	+8.5'	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 48.156
ACOE WATER LEVEL (TIDE):	+9.4 ~~41.8~~	LONGITUDE:	122 20 37.991
WATER DEPTH ACOE MLLW:	41.8	NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

Sectioned into 3 Sections

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
		980000			~~ML~~	ML	~~clayey silt~~ clayey silt with trace v fine sand with fine organics in top couple feet - transition is about 1.3ft Strong petroleum odor black, very top is olive
1 ft		contaminant loss				ML	1.7 ft ~~to~~ transitions to gray clayey silt (more clay than top)
2						ML	~~At 2.7 ft gray~~ RE
3							3.1 ft.
							~~at 3~~ RE gray clayey silt w/ trace of sand in some areas No obvious odor
4							
5		980001					VOA / sulfide sample taken from 4-8 ft section
6							6.1 ft
						SM	gray to brown silty F-M SAND NO odor
7							
8							8.5 - 8.8 ft Zone of clayey / silty sand
9		9.8 ft					Silty F-M SAND B.O.B @ 9.8 ft.

DIV0440EASTWATERWAYCORELOG.DSF 7/24/98

REVIEWED BY: ______ PAGE __ OF __

SEDIMENT CORING LOG (page 1)

Core Number ED-75 (replace) (first core) #1 For composite

DATE SAMPLED:	2/29/98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	10.9
TIME:	1539	% RECOVERY:	87%
UNCORRECTED DEPTH (-FT):	42.2	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	2.8	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 48.096
ACOE WATER LEVEL (TIDE):	3.7	LONGITUDE.	122 20 37.903
WATER DEPTH ACOE MLLW:	43.5	NORTHING:	215234.94
VESSEL:	R/V Nancy Anne	EASTING:	1267626.48
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

36 ; 12 - 3
13.9 - 3 = 10.7

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	INVERVAL	RECOVERY	SEDIMENT TYPE: USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–2.3		980000			ML		Black to dark gray SILT, with abundant trash and organic debris (hair, trash, plant material). Fuel and H_2S odor (HNu measured up to 5.0 ppm)
2.3 (TD 2.3)							2.3'
2.3–3.5					ML/CL		Dark to medium gray clayey SILT with some organic debris (plant fibers). Fuel odor.
3.5							3.5'
3.5–6		980032					(3.5 - 7.4 ft.): Very dark gray CLAY and SILT, with trace amounts of trash debris, Soft. Very moist. (HNu = zero) (VOCs MS/MSD on this sample)

7.4
8.2

ED-75 (replace)

SEDIMENT CORING LOG (page 2)

Core Number ED-75 (First core)

DATE SAMPLED:	7-29-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
6		980032						
1 7								
			7.4				7.4 ft (end of extruded part of core; ~~next~~ bottom core not extruded)	
2 8								
3 9								
4 10								
5								
6								

REVIEWED BY: ____________

PAGE 2 OF 2

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SEDIMENT CORING LOG (page 1)

Core Number ED-75 (2nd core)

DATE SAMPLED:	2/30/98	CORE PENETRATION:	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	11.2
TIME:	1702	% RECOVERY:	90%
UNCORRECTED DEPTH (-FT):	47.7	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	4.2	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	47 34 48.212
ACOE WATER LEVEL (TIDE):	5.1	LONGITUDE.	122 20 37.981
WATER DEPTH ACOE MLLW:	42.6	NORTHING:	215246.79
VESSEL:	R/V Nancy Anne	EASTING:	1267621.36
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Hazy, overcast, 70°F Calm

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SAMPLE DATA: INVERVAL	SAMPLE DATA: RECOVERY	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY	OBSERVATIONS
0–3.6							0 – 3.6 ft: Core sample discarded. No description.	
3.6		980032	3.6		ML/CL		3.6' (top of described core) (3.6-7.6 ft) Very dark gray SILT ~~with some~~ and CLAY, ~~clay~~. Trace amounts of hair and plant debris at top of sample. Soft. Very moist. Weak petrol. odor at top. (HNu = zero)	
4								
5								
6								

3.6
8.59
9.4

DIV0440\EASTWATERWAYCORELOG.DSF 7/24/98

REVIEWED BY: ______

ED 75

SEDIMENT CORING LOG (page 2)

Core Number ED-75 (2nd core)

DATE SAMPLED:	7-30-98	CORE PENETRATION:	
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY:	
TIME:		% RECOVERY:	
UNCORRECTED DEPTH (-FT):		SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):		POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE:	
ACOE WATER LEVEL (TIDE):		LONGITUDE:	
WATER DEPTH ACOE MLLW:		NORTHING:	
VESSEL:	R/V Nancy Anne	EASTING:	
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	

DEPTH		SAMPLE DATA			SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	INVERVAL	RECOVERY	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
6		980032			ML/CL		SILT and CLAY (see above)	
7								
					ML/CL		-7.6- SILT and CLAY, very dark gray; laminated; more clay-rich at top. Soft, very moist	
8								
		980033 "Z"	8.5					
9							-9.0- (gradational contact)	
			9.4		ML/SP		Dark gray SILT and SAND, interlaminated. Sand is mostly fine, also some very fine. Overall coarsens downward (from silt → sand). Very firm, dense. Very moist. Some wood fragments (plant debris) in Sand.	
10								
11							-11.2 ft (bottom of core)	
12								

REVIEWED BY:

SEDIMENT CORING LOG

Core Number CG-1 (Core 1)

DATE SAMPLED:	8/18/98	CORE PENETRATION (FT):	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	6.25
TIME:	0941	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	-37.6	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	-0.5	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 25.273
ACOE WATER LEVEL (TIDE):	+0.4	LONGITUDE (W):	122 20 32.197
WATER DEPTH ACOE MLLW:	-37.2	NORTHING (FT):	218993.45
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268091.45
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Overcast, 55-60° F, calm, wind North <5 knots

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0–3.3		980102		ML/SM	**0.0 to 3.3 feet:** Sandy SILT; sand is mostly very fine; abundant plant debris throughout with possible hair debris; common worm tubes in upper 0.5 feet; very soft in upper 0.5 feet (silt wet); grading down to very firm at 3.3 feet (moist); dark brownish gray; a few white shells. (Gradational)
3.3–4.8		980240 Archive "Z"		SP-SM	**3.3 to 4.8 feet:** Fine SAND, with little silt (8-10%); abundant white shells (both smooth and scalloped shells) up to 1-inch fragments; one large gravel (2.5") at top of unit; no odor; dark gray; silt in discrete layers; also mussel shells.
4.8–6					**4.8 feet:** Bottom of described core.

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DN0440\EASTWATERWAY\CG\CG_1a.DSF 1/15/99

SEDIMENT CORING LOG

Core Number CG-1 (Core 2)

DATE SAMPLED:	8/18/98	CORE PENETRATION (FT):	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	6.2
TIME:	0959	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	-37.8	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	-0.2	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 25.273
ACOE WATER LEVEL (TIDE):	+0.7	LONGITUDE (W):	122 20 32.100
WATER DEPTH ACOE MLLW:	37.1	NORTHING (FT):	219002.64
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268098.28
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Overcast, 55-60° F, calm, wind North <5 knots

DEPTH		SAMPLE DATA	SEDIMENT TYPE		
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0 to 4		980102		ML/SM	**0.0 to 4.1 feet:** Sandy SILT with mostly very fine sand, some fine; some small white shell fragments; common to abundant wood plant debris, including twigs up to 1/2" to 5 1/2"; soft and wet at top; grading to firm and moist at base; dark brownish-gray.
4		Not Sampled			(Gradational)
4.1 to 4.9				SP	**4.1 to 4.9 feet:** Fine SAND, with trace silt (near top only); dense with trace shell fragments.
5					**4.9 feet:** Bottom of described core.
6					

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DM0440\EASTWATERWAY\CG\CG_1b.DSF 1/12/99

SEDIMENT CORING LOG

Core Number CG-2 (Core 1)

DATE SAMPLED:	8/24/98	CORE PENETRATION (FT):	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	12.6 - 0.2 = 12.4
TIME:	1447	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	-38.5	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	2.5	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 26.190
ACOE WATER LEVEL (TIDE):	+3.4	LONGITUDE (W):	122 20 29.242
WATER DEPTH ACOE MLLW:	35.1	NORTHING (FT):	219082.37
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268295.79
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear, 70° F, winds light, West 2-3 knots

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980126	ML/CL		**0.0 to 1.5 feet:** SILT and CLAY, with trace very fine sand with common shells and wood fragments; very dark gray, but oxidized to light gray in upper 2 inches; soft; wet; a few angular gravel fragments also present.
1.5			SP-SM		**1.5 to 2.6 feet:** SAND, with little silt; fine to very fine sand; with silt near top; decreasing downward; moderately dense; dark brownish-gray.
2.6			ML		**2.6 to 4.0 feet:** SILT, with little very fine sand, in layers; one peat/wood layer (w/shells) at bottom (3.9 ft depth); very firm; dark brownish-gray.
4			ML		**4.0 to 5.9 feet:** Similar to above; SILT with trace very fine sand; stiff. (Gradational)
6		980251	ML		**5.9 - 6.8 feet:** Sandy SILT (see next page).

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SEDIMENT CORING LOG

Core Number CG-2 (Core 1)

DEPTH Feet Below Mud Surface	DEPTH Feet Below MLLW	SAMPLE DATA SAMPLE NUMBER	SEDIMENT TYPE USCS	SEDIMENT TYPE SYMBOLS	LITHOLOGY OBSERVATIONS
		980251 "Z" ↓	ML/SP		**5.9 to 6.8 feet:** Sandy SILT, laminated (angled beds); sand is very fine to fine in layers in silt; very firm; dark brown-gray; some wood debris present. (Gradational)
7		Not Sampled ↓	SP		**6.8 to 8.0 feet:** Fine SAND (a little very fine) with trace silt (~5%) in layers, with shell and plant debris locally; mostly clean sand; dark brownish-gray; dense.
8					**8.0 feet:** Bottom of described core.

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SEDIMENT CORING LOG

Core Number CG-2 (Core 2)

DATE SAMPLED:	8/24/98	CORE PENETRATION (FT):	12.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	12.6 - 0.2 = 12.4
TIME:	1512	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	39.2	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	3.4	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 26.190
ACOE WATER LEVEL (TIDE):	4.3	LONGITUDE (W):	122 20 29.242
WATER DEPTH ACOE MLLW:	34.9	NORTHING (FT):	219097.02
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268298.27
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, clear, 70° F, winds light West <5 knots

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.5		980126	ML/CL		**0.0 to 1.5 feet:** SILT and CLAY, with little very fine sand, and some angular gravel in large fragments (up to 3.5") which are common at ~1.0 ft depth; common shells (mussels and white bivalve fragments); abundant wood/plant debris up to 4" long; little hair debris; very dark gray, but oxidized to medium gray in top inch; soft; wet; HNu up to 3 ppm, only in upper half.
1.5–4.0			ML		**1.5 to 4.0 feet:** SILT, with little very fine sand (mainly sandy in top 4 inches); very firm; a few shell fragments in silt; weakly laminated; dark to medium brownish-gray.
4.0–5.1			SM		**4.0 to 5.1 feet:** Silty SAND; sand is very fine to fine; sand and silt are intermixed; very wet; loose to moderately dense; dark gray to brownish-gray.
5.1–6			SP-SM		**5.1 to 8.0 feet:** SAND, with little silt; mostly fine sand; a little very fine sand; some zones of wood plant debris (up to 2" long); dense.

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SEDIMENT CORING LOG

Core Number CG-2 (Core 2)

DEPTH		SAMPLE DATA	SEDIMENT TYPE			
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	USCS	SYMBOLS	LITHOLOGY	OBSERVATIONS
		980126 Not Sampled	SP-SM			
7						
8					8.0 feet: Bottom of described core.	

SEDIMENT CORING LOG

Core Number CG-3 (Core 1)

DATE SAMPLED:	8/26/98	CORE PENETRATION (FT):	11.2
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	10.8 - 1.2 = 9.6
TIME:	1125	% RECOVERY:	86%
UNCORRECTED DEPTH (-FT):	38.8	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	6.0	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 26.145
ACOE WATER LEVEL (TIDE):	6.9	LONGITUDE (W):	122 20 25.846
WATER DEPTH ACOE MLLW:	31.9	NORTHING (FT):	219073.26
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268528.43
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Overcast, 60° F, winds light North ~2-3 knots

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.2		980135	ML		**0.0 to 1.2 feet:** SILT, with trace very fine sand and clay with trace fine subrounded gravels; trace worm tubes and hair fibers; very soft to soft; wet; slight petroleum odor; black.
1.2–3.8		980135 (cont.); 980139, 980140 (field dup)	SM		**1.2 to 3.8 feet:** SAND, fine with some silt and trace shell fragments at 2 feet; trace rootlets; wet; soft from 1.3 to 1.6 feet; more dense and moist from 1.6 to 3.5 feet; very dark gray brown; very silty sand; no odor.
3.8–4.2			ML		**3.8 to 4.2 feet:** SILT, with some fine sand; firm.
4.2–6			SM		**4.2 to 7.5 feet:** SAND, fine with some silt; trace rootlets; dense; moist; dark gray brown; no odor. Stringer of silt (firm from 5.5 - 7.5 feet)

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SEDIMENT CORING LOG

Core Number CG-3 (Core 1)

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
		980139 980140	SM		SAND, as above.
7					
			SM		**7.5 to 9.6 feet:** SAND; fine with some silt; dense; wet; dark gray brown; trace rootlets from 8.5 to 9.6 feet; strong H_2S odor.
8		Archive "Z" 980257			
9					
					9.6 feet: Bottom of core.
10					

SEDIMENT CORING LOG

Core Number CG-3 (Core 2)

DATE SAMPLED:	8/26/98	CORE PENETRATION (FT):	6.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	5.3 - 0.2 = 5.1
TIME:	1155	% RECOVERY:	88%
UNCORRECTED DEPTH (-FT):	38.8	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	5.4	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 26.262
ACOE WATER LEVEL (TIDE):	6.3	LONGITUDE (W):	122 20 25.974
WATER DEPTH ACOE MLLW:	-32.5	NORTHING (FT):	219085.28
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268519.89
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Overcast, 65° F, calm, winds North <2 knots

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1		980135	ML		**0.0 to 1.5 feet:** SILT, with little fine sand; clay; trace fine angular gravels; trace 1" twigs; rootlets and hair fibers; very soft; wet; strong H_2S odor. Grades into SAND
1.5–3.5			SM		**1.5 to 3.5 feet:** SAND, fine with some silt; trace fine gravel/coarse sand; trace hair fibers; trace rootlets; very dense; moist; dark gray-brown.
3.5–6					**3.5 feet:** Bottom of core.

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SEDIMENT CORING LOG

Core Number CG-4 (Core 1)

DATE SAMPLED:	8/24/98	CORE PENETRATION (FT):	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	11.5 - 0.2 = 11.3
TIME:	1309	% RECOVERY:	96%
UNCORRECTED DEPTH (-FT):	33.7	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	0.9	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 26.253
ACOE WATER LEVEL (TIDE):	1.8	LONGITUDE (W):	122 20 20.755
WATER DEPTH ACOE MLLW:	31.9	NORTHING (FT):	219077.37
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268877.54
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Partly cloudy, sun breaks, 65° F, calm, winds light N/NW <3 knots

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0.0–2.6		980127	ML/CL		**0.0 to 2.6 feet:** SILT and CLAY, with little very fine sand and little angular gravel; common shells; some chunks (2") of metal (?); common wood/plant material; very dark gray; wet; soft; no surface oxidation zone.
2.6–4.8		980139 980140 (field dup)	SM		**2.6 to 4.8 feet:** SAND, with some (~15%) silt; sand is very fine to fine; intermixed with silt; common shell fragments and plant/wood material (up to 3" long wood); wet; dark brownish-gray; dense to very dense.
4.8–6			SM/ML		**4.8 to 8.0 feet:** SAND, very fine to fine, with little to some silt; trace rootlets; dark gray-brown; moist; very dense; interbedded with alternating layers of SILT, with little fine sand (2- to 3-inch layers); moist; stiff; dark gray brown to very dark brown.

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SEDIMENT CORING LOG

Core Number CG-4 (Core 1)

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
		980139 980140	SM/ML		
7					
8			ML/SM		**8.0 to 9.4 feet:** SILT, with common very fine sand; very stiff; moist; gray brown; no odor.
9		Archive "Z" 980258			
			SM		**9.4 to 11.5 feet:** SAND, fine to very fine, with some silt; medium dense; trace rootlets; gray brown; moist.
10		Not Sampled			
11					
					11.5 feet: Bottom of core.
12					

SEDIMENT CORING LOG

Core Number CG-4 (Core 2)

DATE SAMPLED:	8/24/98	CORE PENETRATION (FT):	5.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	5.4
TIME:	1408	% RECOVERY:	98%
UNCORRECTED DEPTH (-FT):	34.8	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	1.5	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 26.158
ACOE WATER LEVEL (TIDE):	2.4	LONGITUDE (W):	122 20 20.909
WATER DEPTH ACOE MLLW:	32.4	NORTHING (FT):	219067.95
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268866.79
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Sunny, mostly clear, 65-70° F, winds light West 1-2 knots

DEPTH		SAMPLE DATA	SEDIMENT TYPE		
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
0–1.7		980127	ML/CL		**0.0 to 1.7 feet:** SILT and CLAY, with trash (hair, a screw) and common plant debris and shells; soft; wet; very dark gray; no surface oxidation zone; HNu = zero.
1.7–4.0			ML/SP		**1.7 to 4.0 feet:** SILT and SAND, in about equal amounts; interbedded and intermixed with wood/ plant debris (wood up to 2" long); stiff; dense; dark gray; HNu = zero.
4.0					**4.0 feet:** Bottom of core.

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SEDIMENT CORING LOG

Core Number CG-5 (Core 1)

DATE SAMPLED:	8/18/98	CORE PENETRATION (FT):	7.5
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	7.1
TIME:	1409	% RECOVERY:	95%
UNCORRECTED DEPTH (-FT):	44.6	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	8.8	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 24.457
ACOE WATER LEVEL (TIDE):	9.7	LONGITUDE (W):	122 20 29.377
WATER DEPTH ACOE MLLW:	34.9	NORTHING (FT):	218906.99
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268283.09
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Overcast, 60° F, calm, winds light North <5 knots

DEPTH: Feet Below Mud Surface	DEPTH: Feet Below MLLW	SAMPLE DATA: SAMPLE NUMBER	SEDIMENT TYPE: USCS	SEDIMENT TYPE: SYMBOLS	LITHOLOGY / OBSERVATIONS
0		980104	ML		**0.0 to 3.2 feet:** SILT with some very fine to fine sand, and common wood/plant debris (up to 1" long); a few worm tubes in upper 1/2 foot; no oxidation at surface; soft and wet at surface, grading down to firm and very moist; dark brown-gray grading down to medium gray-brown. (sharp)
3.2			ML/SP		**3.2 to 4.0 feet:** SILT and SAND, in about equal amounts; interbedded; laminated; sand is mostly very fine; some plant debris; very firm; dense; dark brownish-gray; slightly moist.
4.0			ML		**4.0 to 4.8 feet:** SILT, with some (~15%) very fine sand and trace gravel (round, up to 1.3"); stiff; dark brownish-gray; some whitish shells.
4.8		980104 "Z"	SP-SM		**4.8 to 7.1 feet:** SAND with little silt; sand is very fine to fine; dense; dark gray; some shells; laminated; some plant debris.

REVIEWED BY: ______________________

D\04404\EASTWATERWAY\CG\CG_5a.DSF 1/12/99

SEDIMENT CORING LOG

Core Number CG-5 (Core 1)

DEPTH		SAMPLE DATA	SEDIMENT TYPE		
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
		980241 Archive "Z" ↓	SP-SM		
7		Not Sampled			
					7.1 feet: Bottom of core.
8					

SEDIMENT CORING LOG

Core Number CG-5 (Core 2)

DATE SAMPLED:	8/18/98	CORE PENETRATION (FT):	12.0
LOCATION:	East Waterway - Seattle, WA	CORE RECOVERY (FT):	12.5 - 0.2 = 12.3
TIME:	1448	% RECOVERY:	100%
UNCORRECTED DEPTH (-FT):	-46.7	SAMPLING METHOD:	MSS Vibracore
NOS WATER LEVEL (TIDE):	9.7	POSITIONING METHOD:	DGPS
NOS TO ACOE LEVEL CORRECTION:	+0.9	LATITUDE (N):	47 35 24.418
ACOE WATER LEVEL (TIDE):	10.6	LONGITUDE (W):	122 20 29.081
WATER DEPTH ACOE MLLW:	36.1	NORTHING (FT):	218902.65
VESSEL:	R/V Nancy Anne	EASTING (FT):	1268303.30
SAMPLED BY:	SAIC/Herrera/MSS	WEATHER:	Overcast, 60° F, calm, winds North ~1-2 knots

DEPTH		SAMPLE DATA	SEDIMENT TYPE		
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	USCS	SYMBOLS	LITHOLOGY OBSERVATIONS
0–2.8		980104	ML		**0.0 to 2.8 feet:** SILT, with trace little very fine sand; soft, grading down to firm; very dark gray to dark gray; a little plant debris, some hair debris; wet.
2.8–4.7			ML		**2.8 to 4.7 feet:** SILT, with some very fine sand; laminated; stiff; dark brownish-gray; common plant and wood debris (up to 1" x 3.5"); moist to slightly moist (similar to above unit, but harder, more sand, more wood).
4.7–6.3		Not Sampled	SM		**4.7 to 6.3 feet:** SAND with some (~15-20%) silt; some wood/plant debris; very dense; fine to very fine sand.

REVIEWED BY: ____________

SEDIMENT CORING LOG

Core Number CG-5 (Core 2)

DEPTH		SAMPLE DATA	SEDIMENT TYPE		
Feet Below Mud Surface	Feet Below MLLW	SAMPLE NUMBER	USCS	SYMBOLS	LITHOLOGY / OBSERVATIONS
		Not Sampled	SM		
7		↓	ML		**6.3 to 8.0 feet:** SILT, clean; very firm; dark brown-gray.
8					**8.0 feet:** Bottom of described core.

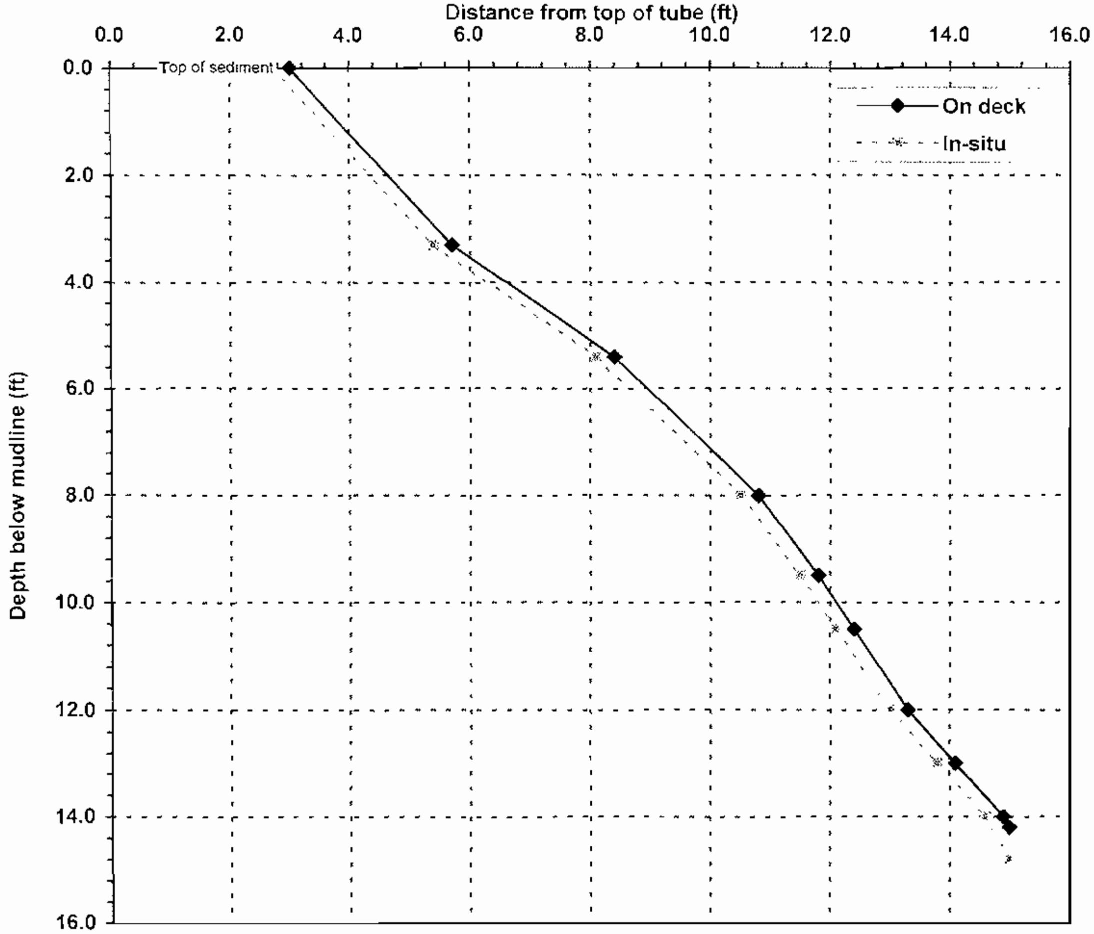
WINDWARD, 2002

Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW-143
Project No: 1257501
Collected by: GSM
Date: 12/7/2001 **Time:** 12:44
Water depth: 51.0 ft **Mudline:** -40.7 ft MLLW (estimated using electronic tide gauge)

Place Field ID Label Here

Weather/Comments: Light SW wind, overcast



Penetration 14.8 ft/ On deck recovery 12 ft = 81% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-3.3	2.7	82%
3 3-5.4	2.7	129%
5.4-8	2.4	92%
8-9.5	1	67%
9.5-10.5	0 6	60%
10.5-12	0.9	60%
12-13	0.8	80%
13-14	0.8	80%
14-14.8	0.4	50%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	3
1	3.82
2	4.64
3	5.45
4	6.60
5	7.89
6	8.95
7	9.88
8	10.80
9	11.47
10	12.10
11	12.70
12	13.30
13	14.10
14	14.90
15	No sample
16	No sample
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample

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Windward environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-143 Station ID: **EW-143**

Project Name: East Waterway Nature and Extent
Uncorrected depth:

Project Number: 08-08-04
NOS water level (tide):

Date: 12/07/01 Time: 12:44
NOS-to-ACOE level correction:

Weather:
ACOE water level (tide):

Crew: Pettee Mudmole w/ Charles Eaton
Water depth (ACOE MLLW):

Core penetration: 14.8 Core recovery: 11.9 Percent recovery:

Depth: Ft below mud surface	Depth: Sample interval	Sample data: Sample number	Sample data: Percent recovery	USCS soil group	Notes: Lithology/observations:
0					
2				ML	Sand Silt, 70% silt, 30% fine sand, DK. Gray, trace shells to 1-inch, with wood pieces to 3-inches Soft to Firm, no odor.
4					
6					silt lenses to 2-inches
8				SP	Sand, 95% medium to Fine, Trace silt, loose, gray brown, Trace red medium sand grains, occassional silty lens to ½-inch
10	51-52'	EW-143-01	60		
	52-53'	EW-143-02	60		
12	53-54'	EW-143-03	80	SP	Same as above. (Sand)
14					14' end of core

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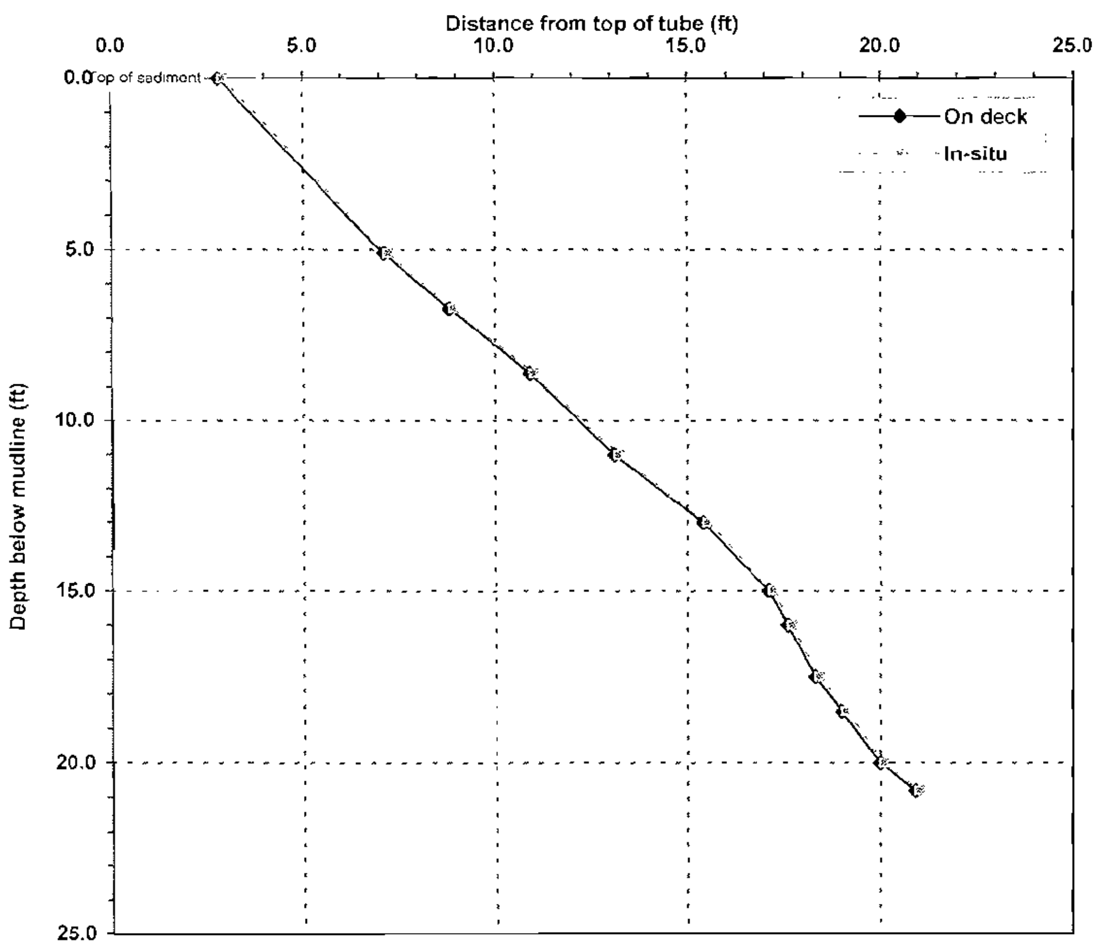
Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW 144
Project No: 1257501
Collected by: GSM
Date: ######## **Time:** 10:58
Water depth: 46.0 ft **Mudline:** -36.5 ft MLLW (estimated using tide tables)

Place Field ID Label Here

Weather/Comments: overcast, calm



Penetration 20.8 ft/ On deck recovery 18.2 ft = 88% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-5.1	4.3	84%
5.1-6.7	1.7	106%
6.7-8.6	2.1	111%
8.6-11	2.2	92%
11-13	2.3	115%
13-15	1.7	85%
15-16	0.5	50%
16-17.5	0.7	47%
17.5-18.5	0.7	70%
18.5-20	1	67%
20-20.8	0.9	113%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	2.8
1	3.64
2	4.49
3	5.33
4	6.17
5	7.02
6	8.06
7	9.13
8	10.24
9	11.27
10	12.18
11	13.10
12	14.25
13	15.40
14	16.25
15	17.10
16	17.60
17	18.07
18	18.65
19	19.33
20	20.00
21	No sample

EW 144-

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Bore Log (mudline)

SEDIMENT CORE COLLECTION FORM

Windward environmental LLC

Core ID: EW-144 Station ID: **EW-144**

Project Name: East Waterway Nature and Extent
Project Number: 08-08-04
Date: 12/11/01 Time: 10:58
Weather:
Crew: Pentec Mudmole w/ Charles Eaton
Core penetration: 20' Core recovery: 17 Percent recovery:

Uncorrected depth:
NOS water level (tide):
NOS-to-ACOE level correction:
ACOE water level (tide):
Water depth (ACOE MLLW):

Depth/MLLW: Ft below mud surface	Depth/MLLW: Sample interval	Sample data: Sample number	Sample data: Percent recovery	USCS soil group	Notes: Lithology/observations
0–6				ML/SM	ML/S Silt w/sand, 80% silt, 20% Fine sand, gray to dk. gray. Very soft to soft, sulfur/decay odor
6–14				SM	Silty Sand, 90% fine sand, 10% silty, loose to medium Firm, gray, no odor, Trace wood Frags. Trace silty lensing to 4 inches thick.
14–15				SP	Sand, 100% medium to Fine, loose to medium, Trace wood Fragments to 1-inch, Trace red sands, Trace silt, no odor.
15–16	51-52'	EW-144-01	50		
16–17	52-53'	EW-144-02	47		
17–18	53-54'	EW-144-03	70		
20					End of core tube

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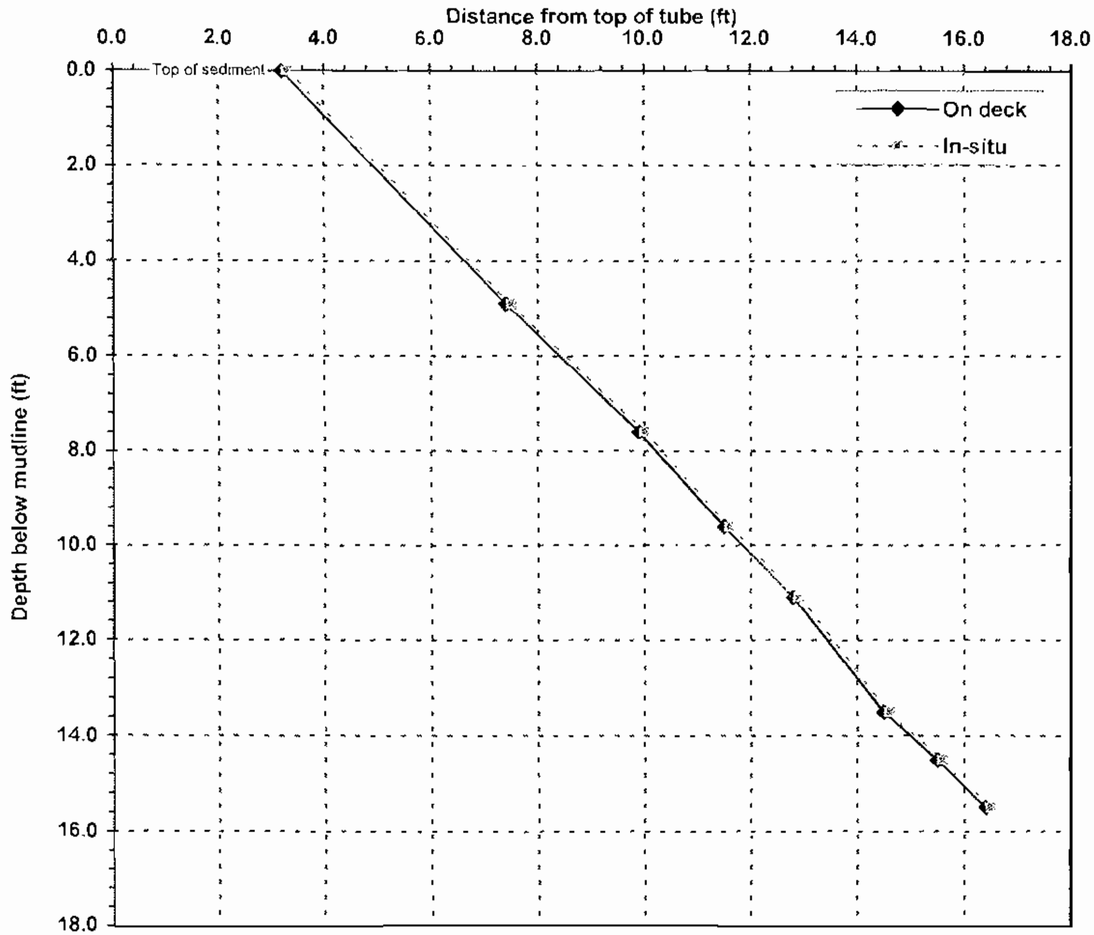
Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW145
Project No: 1257501
Collected by: GSM
Date: ######## **Time:** 12:41
Water depth: 55.0 ft **Mudline:** -43.3 ft MLLW (estimated using electronic tide gauge)

Place Field ID Label Here

Weather/Comments: calm, overcast



Penetration 15.5 ft/ On deck recovery 13.3 ft = 86% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-4.9	4.2	86%
4.9-7.6	2.5	93%
7.6-9.6	1.6	80%
9.6-11.1	1.3	87%
11.1-13 5	1.7	71%
13.5-14.5	1	100%
14.5-15.5	0.9	90%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	3.2
1	4.06
2	4.91
3	5.77
4	6.63
5	7.49
6	8.42
7	9.34
8	10.22
9	11.02
10	11.85
11	12.71
12	13.44
13	14.15
14	15.00
15	15.95
16	No sample
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample

Wind Ward environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-145 Station ID: EW-145

Project Name: East Waterway Nature and Extent

Uncorrected depth:

Project Number: 08-08-04

NOS water level (tide):

Date: 12/11/01 Time: 12:41

NOS-to-ACOE level correction:

Weather:

ACOE water level (tide):

Crew: Pettet Mudmole w/ Charles Eaton

Water depth (ACOE MLLW):

Core penetration: 15.5 Core recovery: 14' see Bore log Percent recovery: see Bore Log

Depth / MLLW		Sample data		USCS soil group	Notes:
Ft below mud surface	Sample interval	Sample number	Percent recovery		Lithology/observations:
0–2				ML	Silt with Sand, 80% silt, 15% Fine sand, v. dk. gray, Very soft to soft, Trace wood to 1-inch,
4					- gray silt lens to four inches thick
					Same as above dk. gray.
6					Same as above - gray
8	51 - 52'	EW-145-01	80		Same as above, "sticky"
	52 - 53'	EW-145-02	87		Silt with very Fine sand.
10	53 - 54'	EW-145-02	87		increased sand to 30% mild H.C odor, ~~trace sheen~~. (Hydrocarbon)
12				SP	Sand, 90% medium to Fine, 10% silty, 1/4 to 1/2-inch silty Lenses (occasional).
14					
16					End of core

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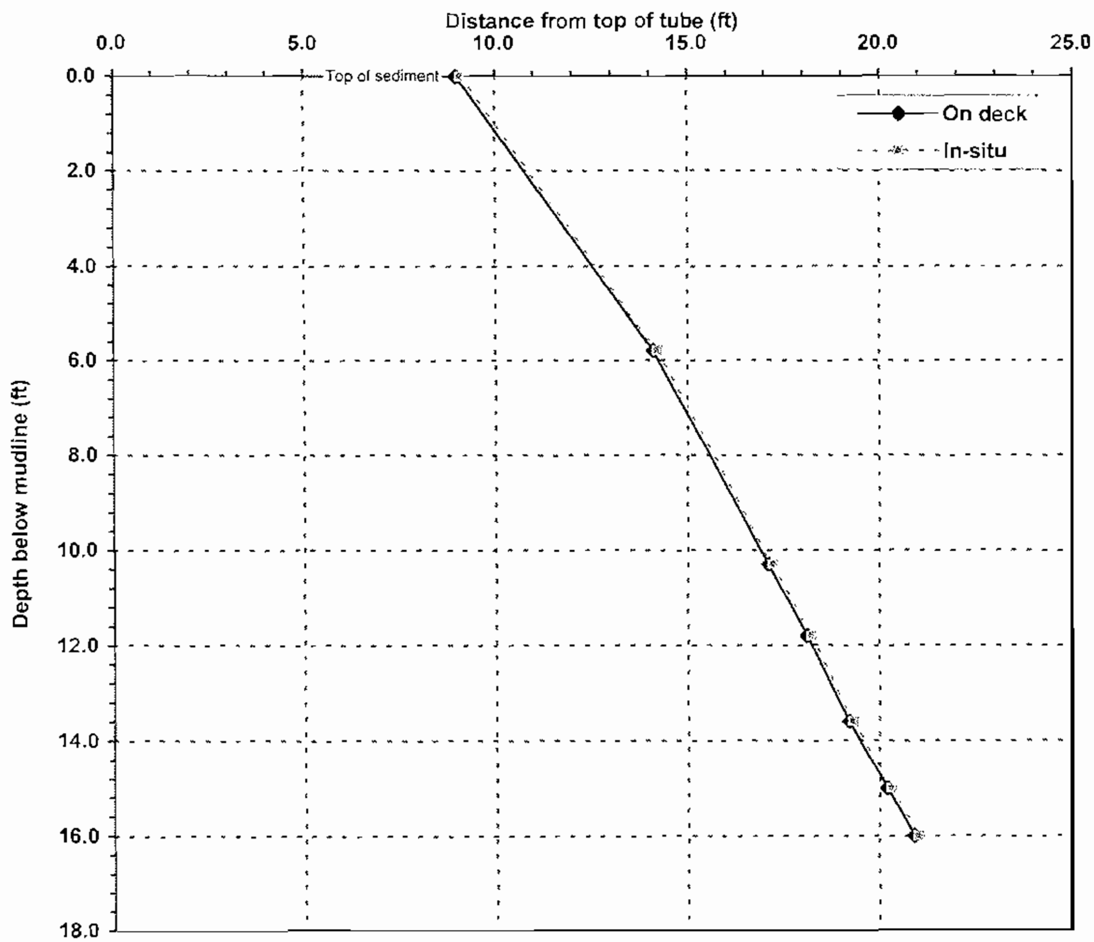
Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW 146
Project No: 1257501
Collected by: GSM
Date: ######## **Time:** 13:03
Water depth: 53.0 ft **Mudline:** -41.0 ft MLLW (estimated using tide tables)

Place Field ID Label Here

Weather/Comments: partly cloudy, calm



Penetration 16 ft/ On deck recovery 12 ft = 75% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-5.8	5.1	88%
5.8-10.3	3	67%
10.3-11.8	1	67%
11.8-13.6	1.1	61%
13.6-15	1	71%
15-16	0.7	70%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	9
1	9.88
2	10.76
3	11.64
4	12.52
5	13.40
6	14.23
7	14.90
8	15.57
9	16.23
10	16.90
11	17.57
12	18.22
13	18.83
14	19.49
15	20.20
16	16.00
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample

WindWard environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-146 Station ID: **EW-146**

Project Name: East Waterway Nature and Extent
Uncorrected depth:
Project Number: 08-08-04
NOS water level (tide):
Date: 12/11/01 Time: 13:03
NOS-to-ACOE level correction:
Weather:
ACOE water level (tide):
Crew: Pentec Mud Mole and Charles Eaton
Water depth (ACOE MLLW):
Core penetration: 16 Core recovery: ~~14~~ 11 see Bore log Percent recovery: see Bore Log

Depth/MLLW		Sample data		USCS soil group	Notes:
Ft below mud surface	Sample interval	Sample number	Percent recovery		Lithology/observations:
0–2				ML/SM	Silt with sand, 60% silt, 40% very fine sand, dk. gray, soft, some wood pieces, trace shells.
10–11	-51 - 52'	EW-146-01	67		Same as above "sticky" to sample decay sulfur odor, very dark gray, soft.
11–12	-52 - 53'	EW-146-02	61		
12–13	-53 - 54'	EW-146-03	61		
14–16				SP	Sand, about 100% medium to fine, Brownish gray, Loose, trace ferrous.
16					end of core tube

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16

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Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW-147

Project No: 1257501

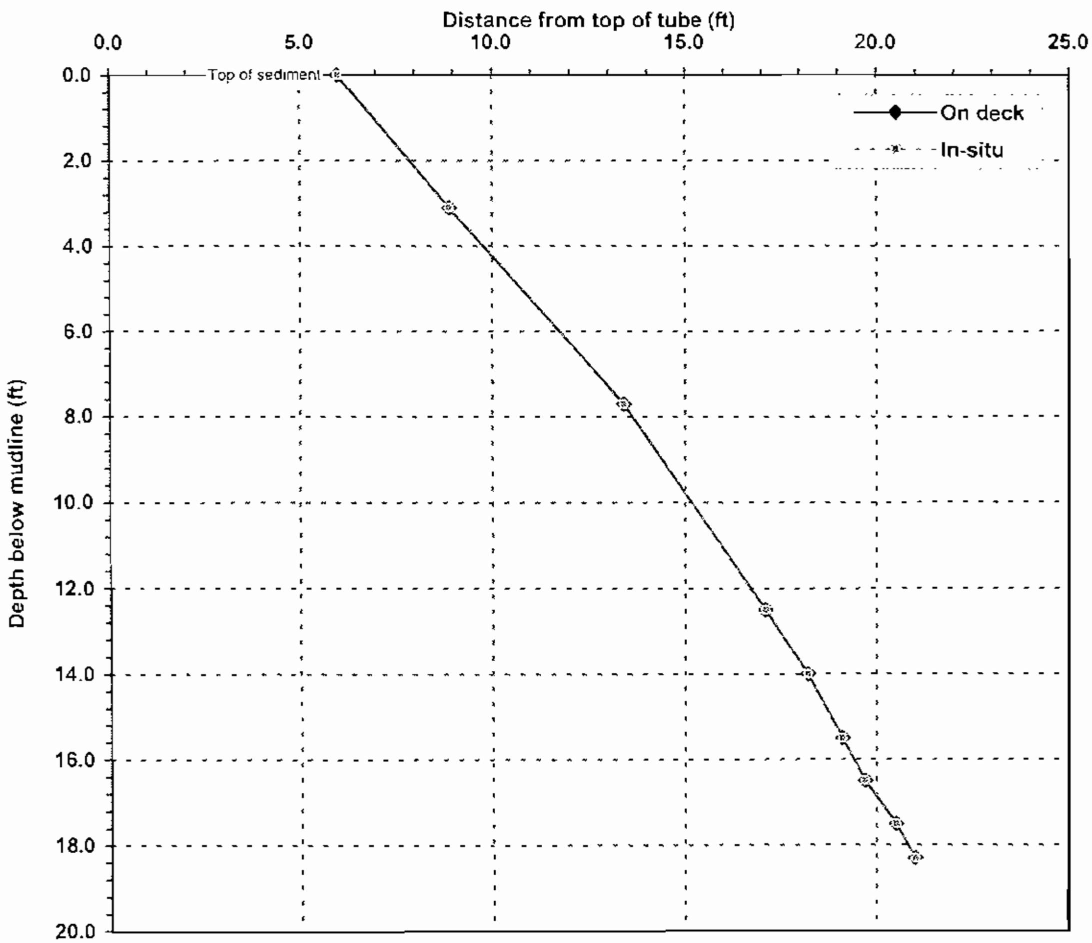
Collected by: GSM

Date: 12/7/2001 **Time:** 14:09

Water depth: 46.0 ft **Mudline:** -38.1 ft MLLW (estimated using electronic tide gauge)

Place Field ID Label Here

Weather/Comments: Light SW wind, overcast



Penetration 18.3 ft/ On deck recovery 15 ft = 82% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-3.1	2.9	94%
3.1-7 7	4.5	98%
7 7-12 5	3.7	77%
12.5-14	1.1	73%
14-15.5	0.9	60%
15.5-16.5	0.6	60%
16.5-17 5	0.8	80%
17.5-18.3	0.5	62%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	6
1	6.94
2	7.87
3	8.81
4	9.78
5	10.76
6	11.74
7	12.72
8	13.63
9	14.40
10	15.17
11	15.94
12	16.71
13	17.47
14	18.20
15	18.80
16	19.40
17	20.10
18	20.81
19	No sample
20	No sample
21	No sample

Windward environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-147 Station ID: **EW-147**

Project Name: East Waterway Nature and Extent

Uncorrected depth:

Project Number: 08-08-04

NOS water level (tide):

Date: 12/07/01 Time: 1409

NOS-to-ACOE level correction:

Weather:

ACOE water level (tide):

Crew: Pearce w/ C. Eaton

Water depth (ACOE MLLW):

Core penetration: 18' See Pearce Bore Log Core recovery: 15' Percent recovery: 85%

Depth / MLLW		Sample data		USCS soil group	Notes:
Ft below mud surface	Sample interval	Sample number	Percent recovery		Lithology/observations:
4				ML/SM	Sandy Silt, about 50% fine sand, 50% silts, dk gray to black, soft, trace shells, trace wood fragments
6					
8					Same as above
10				SP	Sand, 90% fine to medium, gray brown, loose to medium dense, trace silty.
12					
	51-52'	EW-147-01	73		
14	52-53'	EW-147-02	60		Same as above. Sand
	53-54'	EW-147-03	60		
16					
18					Same as above. Sand
					Bottom of core ~~20.5~~

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Mudmole™ Bore Log

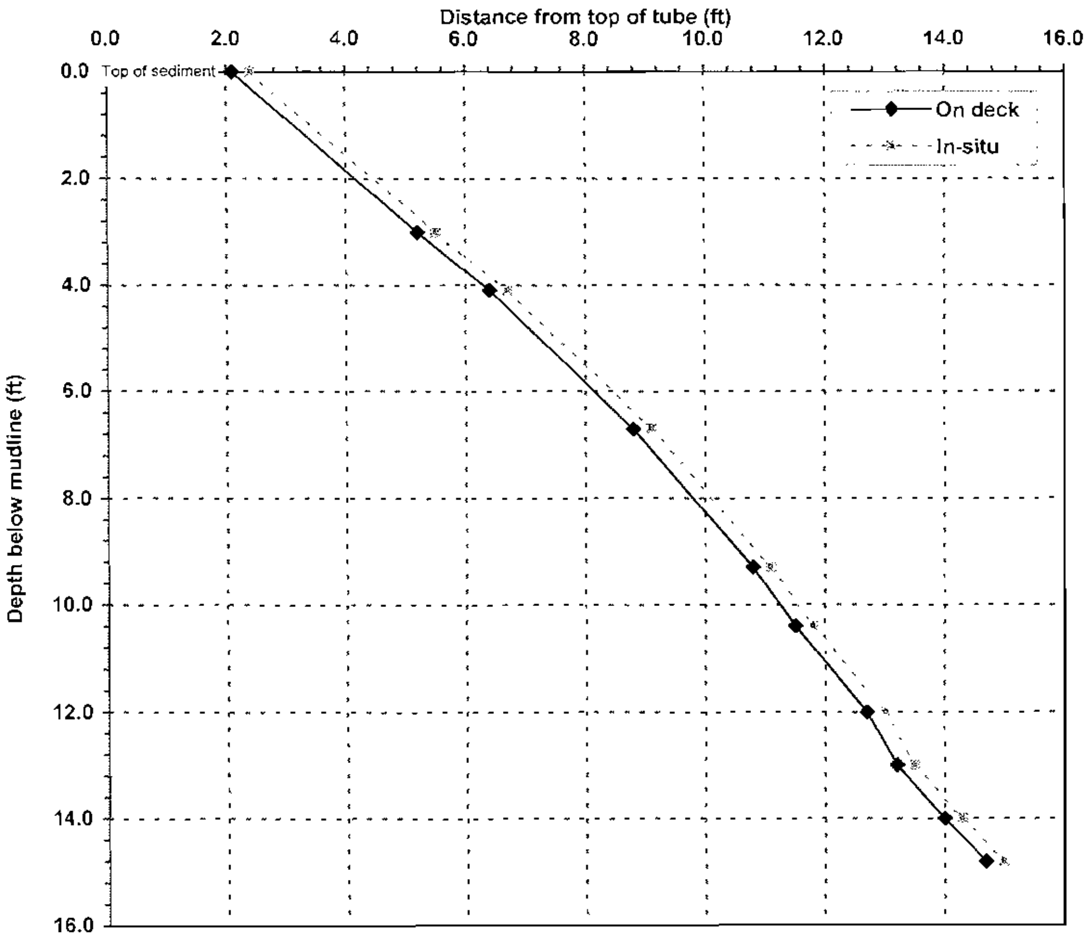
Project: Windward Eastwaterway **Station:** EW 148
Project No: 1257501
Collected by: GSM
Date: ######## **Time:** 9:22
Water depth: 48.0 ft **Mudline:** -41.1 ft MLLW (estimated using electronic tide gauge)

Weather/Comments: calm, overcast

Place Field ID Label Here

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-3	3.1	103%
3-4.1	1.2	109%
4.1-6.7	2.4	92%
6.7-9.3	2	77%
9.3-10.4	0.7	64%
10.4-12	1.2	75%
12-13	0.5	50%
13-14	0.8	80%
14-14.8	0.7	87%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	2.1
1	3.13
2	4.17
3	5.20
4	6.29
5	7.23
6	8.15
7	9.03
8	9.80
9	10.57
10	11.25
11	11.95
12	12.70
13	13.20
14	14.00
15	No sample
16	No sample
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample



Penetration 14.8 ft/ On deck recovery 12.9 ft = 87% Recovery

WindWard environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-148 Station ID: **EW-148**

Project Name: East Waterway Nature and Extent

Uncorrected depth:

Project Number: 08-08-04

NOS water level (tide):

Date: 12/11/01 Time: 9:22

NOS-to-ACOE level correction:

Weather:

ACOE water level (tide):

Crew: Pentec w/Mud Mole and Charles Eaton

Water depth (ACOE MLLW):

Core penetration: Core recovery: Percent recovery:

Depth: Ft below mud surface	Depth: Sample interval	Sample data: Sample number	Sample data: Percent recovery	USCS soil group	Notes: Lithology/observations:
0–7.5				ML/SM	Silty Sand, 40% Fine sand, 40% silt, 20% woody, vegetive Fragments with paper, metal, cigs, very loose to loose, dk. gray. S.A.A (Same as above)
7.5–10				SP	Sand, about 100% medium to fine occassional silty sand lens to ½-inch. dk. gray, loose, trace red sands.
10–11	51–52	EW-148-01	70	SP	Same as above.
11–12	52–53	EW-148-02	75		
12–13	53–54	EW-148-03	50		
14					End of core Log

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Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW 149

Project No: 1257501

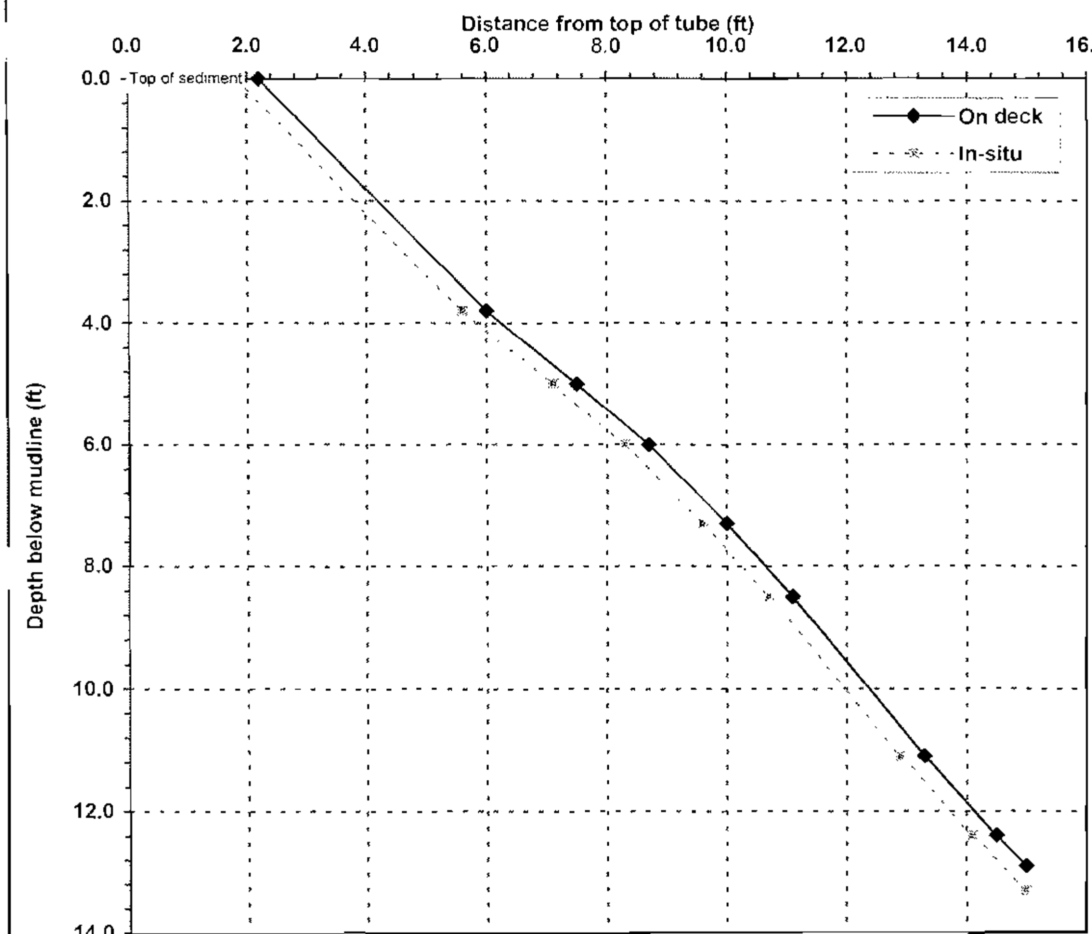
Collected by: GSM

Date: ######## **Time:** 10:31

Water depth: 52.0 ft **Mudline:** -43.4 ft MLLW (estimated using electronic tide gauge)

Place Field ID Label Here

Weather/Comments: overcast, calm



Penetration 13.3 ft/ On deck recovery 12.8 ft = 96% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-3.8	3.8	100%
3.8-5	1.5	125%
5-6	1.2	120%
6-7.3	1.3	100%
7.3-8.5	1.1	92%
8.5-11.1	2.2	85%
11.1-12.4	1.2	92%
12.4-13.3	0.9	100%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	2.2
1	3.20
2	4.20
3	5.20
4	6.25
5	7.50
6	8.70
7	9.70
8	10.64
9	11.52
10	12.37
11	13.22
12	14.13
13	No sample
14	No sample
15	No sample
16	No sample
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample

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Wind Ward environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-149 Station ID: EW-149

Project Name: East Waterway Nature and Extent

Project Number: 08-08-04

Date: 12/11/01 Time: 1300

Weather:

Crew: Pentec Mud Mole w/ Charles Eaton

Core penetration: 13.3

Core recovery: 12' see Bore Log

Uncorrected depth:

NOS water level (tide):

NOS-to-ACOE level correction:

ACOE water level (tide):

Water depth (ACOE MLLW):

Percent recovery: See Bore Log.

Depth: Ft below mud surface	Depth: Sample interval	Sample data: Sample number	Sample data: Percent recovery	USCS soil group	Notes: Lithology/observations:
0–3				SM	Silty Sand, 60% fine sand, 40% silty, soft, dk. gray, trace bedding to 6-inches.
3–4				SP	Sand, 100% medium to fine sand lense, Brown, trace silty.
4–7				SM	Silty Sand, 80% fine, 20% silty, loose to medium, dk. gray, trace wood
7–12				SP	Sand, about 100% fine to medium dk. grayish brown, loose to med. no odor.
8	57 - 52	EW-149-01	90		
	52 - 53	EW-149-02	85		
10	53 - 54	EW-149-03	85		
12					Bottom of core tube
14					

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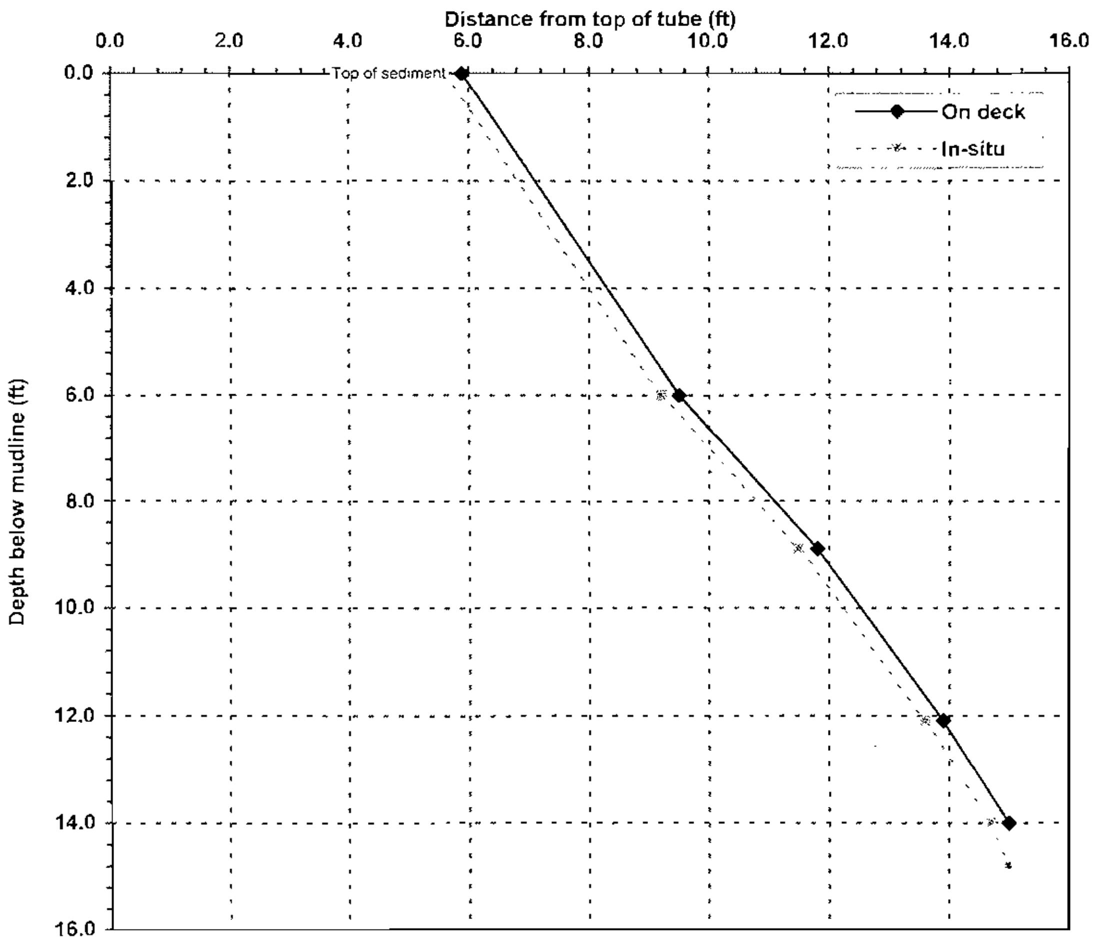
Mudmole Bore Log

Project: Windward Eastwaterway **Station:** EW-150
Project No: 1257501
Collected by: GSM
Date: 12/7/2001 **Time:** 9:53
Water depth: 56.0 ft **Mudline:** -44.2 ft MLLW (estimated using electronic tide gauge)

Place Field ID Label Here

Weather/Comments: Calm, partly cloudy



Penetration 14.8 ft/ On deck recovery 9.1 ft = 61% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-6	3.6	60%
6-8.9	2.3	79%
8.9-12.1	2.1	66%
12.1-14	1.1	58%
14-14.8	0.3	38%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	5.9
1	6.50
2	7.10
3	7.70
4	8.30
5	8.90
6	9.50
7	10.29
8	11.09
9	11.87
10	12.52
11	13.18
12	13.83
13	14.42
14	No sample
15	No sample
16	No sample
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample

Wind Ward environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-150 Station ID: EW-150

Project Name: East Waterway Nature and Extent

Project Number: 08-08-04

Date: 12/7/01 Time: 9:53

Weather:

Crew: Pence Mudside w/ Charles Eaton

Core penetration: 14.8

Core recovery: 8.5 see Bore Log

Uncorrected depth:

NOS water level (tide):

NOS-to-ACOE level correction:

ACOE water level (tide):

Water depth (ACOE MLLW):

Percent recovery: See Bore Log Graph

Depth: Ft below mud surface	Depth: Sample interval	Sample data: Sample number	Sample data: Percent recovery	USCS soil group	Notes: Lithology/observations:
0–6				ML	Silt, 90% silt w/ 10% Fine sand, gray Black, very soft, Trace wood fibers.
6–~7.5				SM	Silty Sand, 60% Fine sand, 35% silt, gray to Black, soft to loose, Trace wood Frag., Hydrocarbon odor.
~7.5–8	-51 – 52	EW-150-01	79		
8–9	-52 – -53	EW-150-02	79		
9–10	-53 – -54	EW-150-03	66		same as above - Brownish Black
~11–13				SP/SM	Sand with Silt, 90% medium to Fine, 10% silty, loose-medium dense, gry Blk to Brown
13					End of Core

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16

Page 1 of 1

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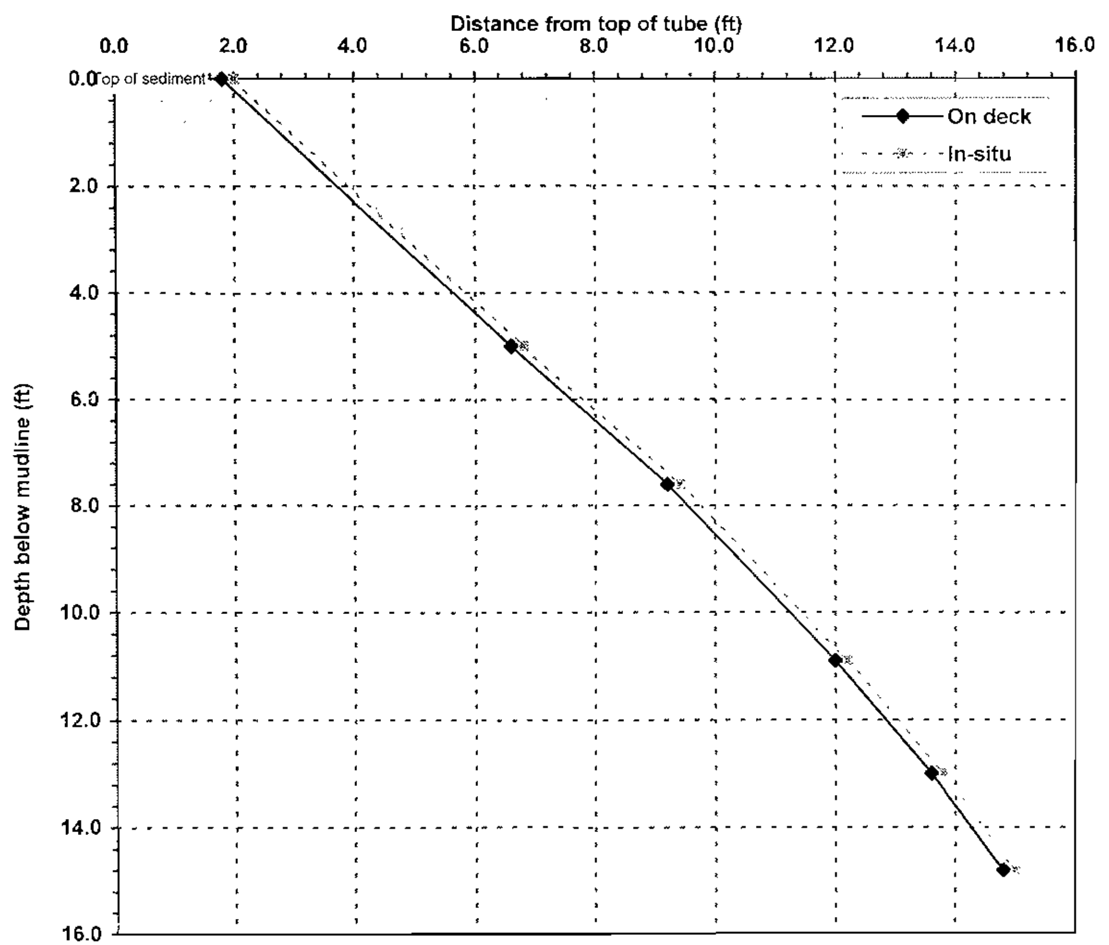
Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW-151
Project No: 1257501
Collected by: GSM
Date: 12/7/2001 **Time:** 10:21
Water depth: 56.0 ft **Mudline:** -44.0 ft MLLW (estimated using electronic tide gauge)

Place Field ID Label Here

Weather/Comments: Light SW wind, partly cloudy



Penetration 14.8 ft/ On deck recovery 13.2 ft = 89% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-5	4.8	96%
5-7.6	2.6	100%
7.6-10.9	2.8	85%
10.9-13	1.6	76%
13-14.8	1.2	67%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	1.8
1	2.76
2	3.72
3	4.68
4	5.64
5	6.60
6	7.60
7	8.60
8	9.54
9	10.39
10	11.24
11	12.08
12	12.84
13	13.60
14	14.27
15	No sample
16	No sample
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample

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File ı .W-151 xls
Bore Log (mudline)

Windward environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-151 Station ID: **EW-151**

Project Name: East Waterway Nature and Extent

Uncorrected depth:

Project Number: 08-08-04

NOS water level (tide):

Date: 12/7/01 Time: 10:21

NOS-to-ACOE level correction:

Weather:

ACOE water level (tide):

Crew: Pentec w/ Mud Nuke and Charles Eaton

Water depth (ACOE MLLW):

Core penetration: Core recovery: Percent recovery:

Depth: Ft below mud surface	Depth: Sample interval	Sample data: Sample number	Sample data: Percent recovery	USCS soil group	Notes: Lithology/observations:
				ML/SM	Sand Silt, 50% Fine sand, 50% silty, soft, gray black,
2				SP	Sand, 100% medium, gray-blk, loose, 6-inch lense, organic decay odor,
4				ML	~~clayey~~ silt, ~~20~~/80% silt, soft, gray Brown, 4-inch silt lense.
				SM	sand with silt, 80% Fine sand, 20% silty, gray brown, loose.
6					
	51–52	EW-151-01	85	SP	Sand, 90% fine sand, 10% silt, gray brown, Loose to medium,
8	52–53	EW-151-02	85		
	53–54	EW-152-03	85		
10					
12				SP	Same as above, grading coarser.
14					End of core
16					

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Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW 152

Project No: 1257501

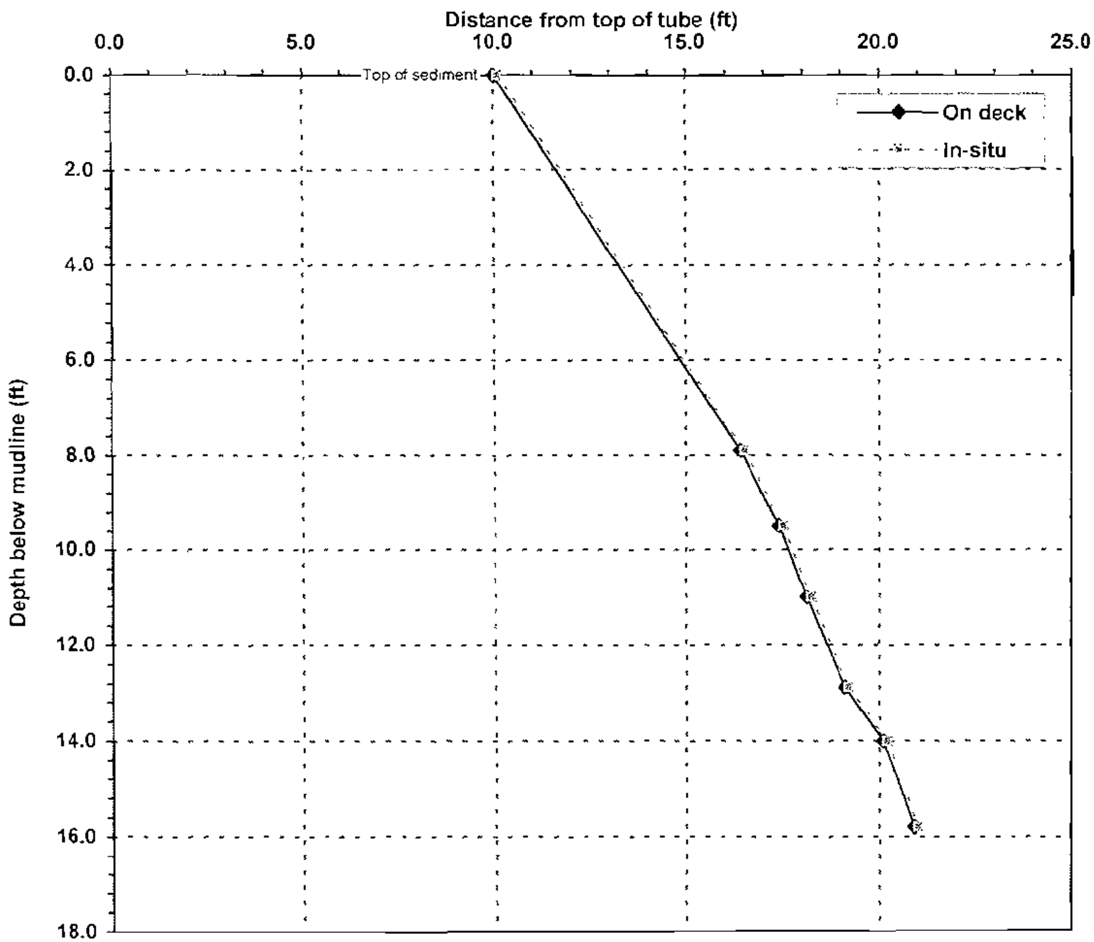
Collected by: GSM

Date: ######## **Time:** 13:43

Water depth: 54.0 ft **Mudline:** -42.0 ft MLLW (estimated using tide tables)

Place Field ID Label Here

Weather/Comments: partly cloudy, calm



Penetration 15.8 ft/ On deck recovery 11 ft = 70% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-7.9	6.4	81%
7.9-9.5	1	63%
9.5-11	0.7	47%
11-12.9	1	53%
12.9-14	1	91%
14-15.8	0.8	44%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	10
1	10.81
2	11.62
3	12.43
4	13.24
5	14.05
6	14.86
7	15.67
8	16.48
9	17.09
10	17.63
11	18.10
12	18.63
13	19.19
14	20.10
15	20.54
16	No sample
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample

SEDIMENT CORE COLLECTION FORM

Wind/Ward environmental LLC

Core ID: EW-152 Station ID: **EW-152**

Project Name:	East Waterway Nature and Extent	Uncorrected depth:	
Project Number:	08-08-04	NOS water level (tide):	
Date: 12/11/01	Time: 13:43	NOS-to-ACOE level correction:	
Weather:		ACOE water level (tide):	
Crew:	Pentec w/ Mud Mole, and Charles Eason	Water depth (ACOE MLLW):	
Core penetration: 15.8	Core recovery: 10.5 see Borelog	Percent recovery:	see Borelog Graph.

Depth: Ft below mud surface	Depth: Sample interval	Sample data: Sample number	Sample data: Percent recovery	USCS soil group	Notes: Lithology/observations:
2, 4, 6				ML	Silt w/sand, 80% silt, 20% Fine sand dk. gray, very soft, trace wood, silt lense to 6-inches at 5' depth,
8				SM	Silty sand, 70% fine sand, 30% silty, soft/loose, dk. gray, trace wood to 4-inches.
10	51-52	EW-152-01	63	SP	Sand, 95% medium to fine, Brownish gray, loose, trace wood, silt and red sands, (no odor).
	52-53	EW-152-02	47		
12	53-54	EW-152-03	53		Same as above.
14				SP	
					End of core
16, 18, 20					

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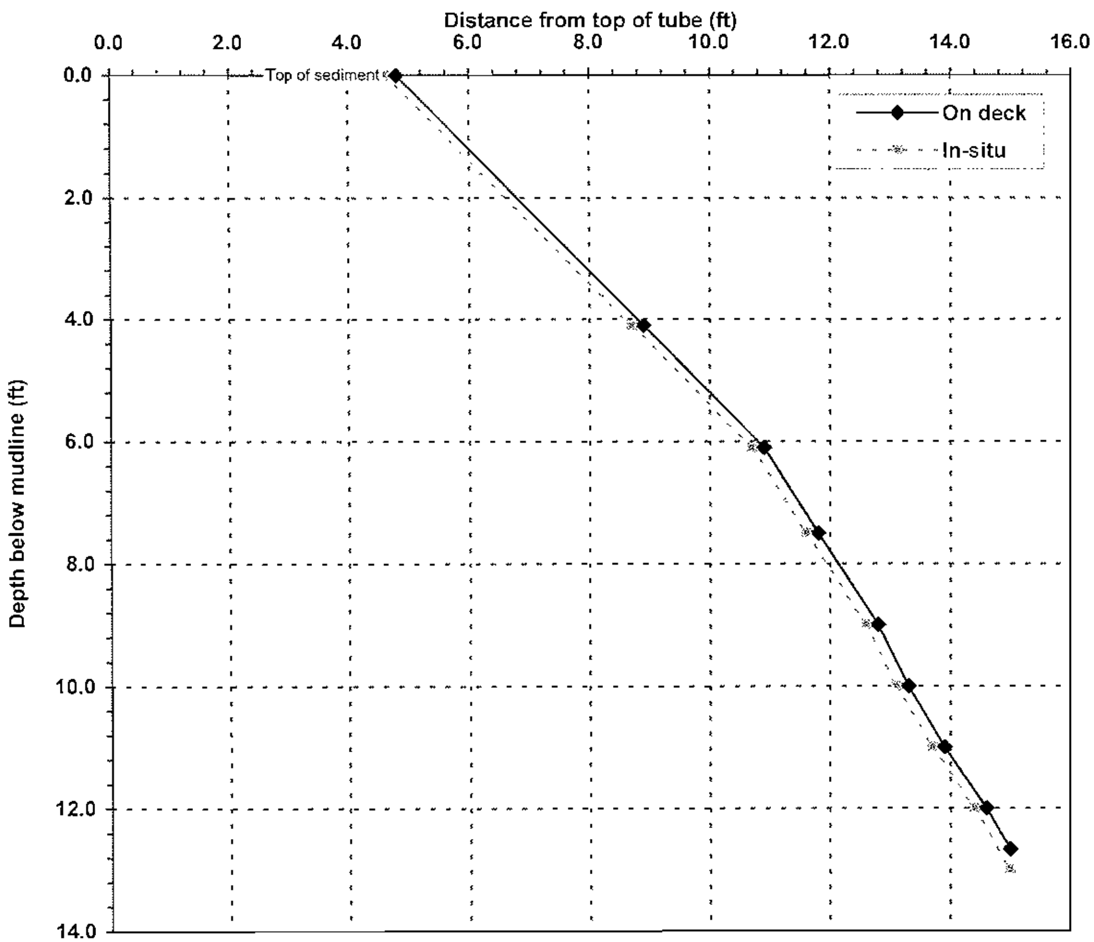
Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW-153
Project No: 1257501
Collected by: GSM
Date: 12/7/2001 **Time:** 13:16
Water depth: 50.0 ft **Mudline:** -40.4 ft MLLW (estimated using electronic tide gauge)

Place Field ID Label Here

Weather/Comments: Light SW wind, overcast



Penetration 13 ft/ On deck recovery 10.2 ft = 78% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-4.1	4.1	100%
4.1-6.1	2	100%
6.1-7.5	0.9	64%
7.5-9	1	67%
9-10	0.5	50%
10-11	0.6	60%
11-12	0.7	70%
12-13	0.6	60%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	4.8
1	5.80
2	6.80
3	7.80
4	8.80
5	9.80
6	10.80
7	11.48
8	12.13
9	12.80
10	13.30
11	13.90
12	14.60
13	No sample
14	No sample
15	No sample
16	No sample
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample

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File name EW-153 xls
Bore Log (mudline)

Windward environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-153 Station ID: **EW-153**

Project Name: East Waterway Nature and Extent
Uncorrected depth:
Project Number: 08-08-04
NOS water level (tide):
Date: 12/07/01 Time: 13:16
NOS-to-ACOE level correction:
Weather:
ACOE water level (tide):
Crew: Pentec Mud Mole w/ Charles Eaton
Water depth (ACOE MLLW):
Core penetration: 13' Core recovery: 10' see Bore Log Percent recovery: see Bore Log Graph

Depth: Ft below mud surface	Depth: Sample interval	Sample data: Sample number	Sample data: Percent recovery	USCS soil group	Notes: Lithology/observations
0–4				SM	Silty Sand, 80% Fine sand, 20% silt, soft/loose, dk. gray, Trace shells, some wood Fibers, light Hydrocarbon odor
~4.5				SP	Sand loose 4-inches Thick, gray, Hydrocarbon odor.
~4.5–5				SM	S.I.A.A.
5–11.5				SP	Sand, 95% Fine to medium gray, loose to medium, Trace Hydrocarbon odor.
11.5–12.5	51-52	EW-153-01	70	SP	same as above.
12.5–13.5	52-53	EW-153-02	NA		End of core.
13.5–14.5	53-54	EW-153-03	NA		

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16

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Mudmole™ Bore Log

Project: Windward Eastwaterway **Station:** EW 154

Project No: 1257501

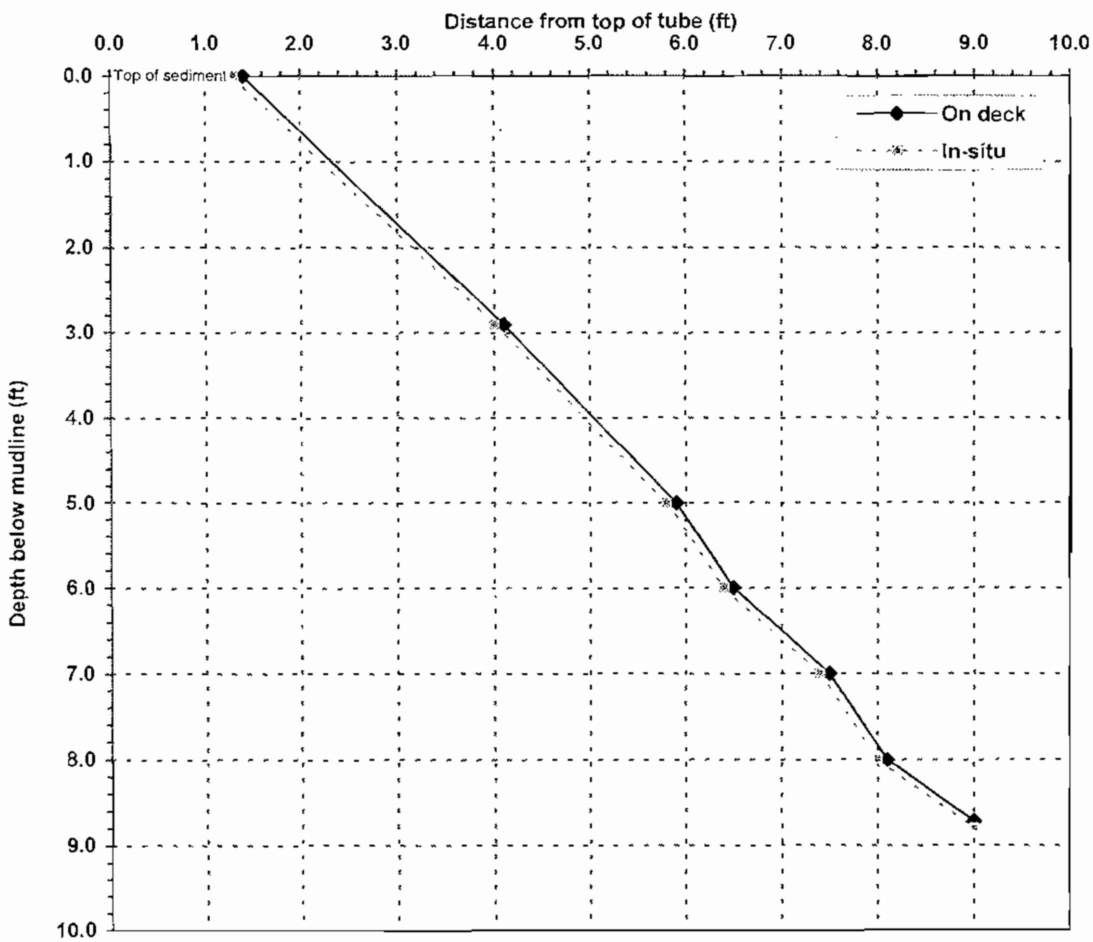
Collected by: GSM

Date: ######## **Time:** 9:53

Water depth: 57.0 ft **Mudline:** -49.4 ft MLLW (estimated using electronic tide gauge)

Place Field ID Label Here

Weather/Comments: overcast, calm



Penetration 8.8 ft/ On deck recovery 7.6 ft = 86% Recovery

Penetration interval (ft)	Interval recovery (ft)	Percent recovery
0-2.9	2.7	93%
2.9-5	1.8	86%
5-6	0.6	60%
6-7	1	100%
7-8	0.6	60%
8-8.8	1	125%

Depth below mudline (ft)	Distance from top of tube (ft)
Mudline	1.4
1	2.33
2	3.26
3	4.19
4	5.04
5	5.90
6	6.50
7	7.50
8	8.10
9	No sample
10	No sample
11	No sample
12	No sample
13	No sample
14	No sample
15	No sample
16	No sample
17	No sample
18	No sample
19	No sample
20	No sample
21	No sample

EW-154 —

WindWard environmental LLC

SEDIMENT CORE COLLECTION FORM

Core ID: EW-154 Station ID: EW-154

Project Name: East Waterway Nature and Extent

Project Number: 08-08-04

Date: 12/11/01 Time: 9:53

Weather:

Crew: Pentec Mud Mole w/ Charles Eaton

Uncorrected depth:

NOS water level (tide):

NOS-to-ACOE level correction:

ACOE water level (tide):

Water depth (ACOE MLLW):

Core penetration: 8.8 Core recovery: 7.7 See Bore log Percent recovery: See Bore log Graph

Depth MLLW		Sample data		USCS soil group	Notes:
Ft below mud surface	Sample interval	Sample number	Percent recovery		Lithology/observations:
0–2				ML/SM	Silty Sand, 40% silt, 60% fine sand, dk-gray, loose/soft, some wood fragments and decay odor.
2	-51 -52	EW-154-01	93	SP	Sand, 95% medium to fine silt loose to 1-inch. (occasional) gray to dk. gray, trace red sands, loose to medium.
4	-52 -53	EW-154-02	86		
	-53 -54	EW-154-03	86		
6					
8					End of Core
10					

ANCHOR, 2006

Visual Classification of Subsurface Core

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Port of Seattle	Date	7/12/06
Job No.	050003-02	Core Pushed By	RB, RP
Exploration No.	T30	Core Logged By	LV, RB
Core No.	T30-SI-01A	Type of Core	☐ Shelby ☐ Piston Core ☒ Other Vibracore 4"
Water Depth/Elevation of Core	-41.7 ft MLLW	Diameter of Core (inches)	4
Cored Length (feet; from log)	13 ft	Core Quality	☒ Good ☐ Fair ☐ Poor ☐ Disturbed
Core Recovery (feet)	12.9 ft ⇒ processed 12 ft'	Average % Compaction =	

Depth in (ft) (Core Sections: Theoretical / Actual)	Sample Interval	Sample Analytes	Classification and Remarks (Color, Consistency, Moisture, Grain Size, Sheen, Odor)
0–2 ft	X (0–4 ft)	PSDDA List	Wet, dk. grey, sl. sandy silt, no odor, no biological
			↓ grades to ↓
2 ft			moist, gray/brow, silty fine sand, no odor
4 ft			few interbedded layers of sl. sandy silt, Lt. Brown
6 ft			
8 ft			
8.2 ft			Interbed layers of moist, brown, clayey sandy silt, no odor
8.6 ft			gray/brown, silty f. sand, moist, no odor
10 ft			
12 ft			

Visual Classification of Subsurface Core

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Port of Seattle	Date	7/12/06
Job No.	050003-02	Core Pushed By	RB, RP
Exploration No.	T30	Core Logged By	RB, LV
Core No.	T30 - S1 - 01B	Type of Core	☐ Shelby ☐ Piston Core ☒ Other Vibracore 4"
Water Depth/Elevation of Core	~40.4 ft MLLW	Diameter of Core (inches)	4
Cored Length (feet; from log)	13.0	Core Quality	☑ Good ☐ Fair ☐ Poor ☐ Disturbed
Core Recovery (feet)	12.2	Average % Compaction =	

Core Sections: Theoretical / Depth in (ft) / Actual	Sample Interval	Sample Analytes	Classification and Remarks (Color, Consistency, Moisture, Grain Size, Sheen, Odor)
			wet, gray/black, sl. sandy silt, ~~no~~ odor, no biological
			moist, gray/blk, silty sandy ~~[illegible]~~ fibrous wood, mod. S^{2-} odor
2ft			semi-dry, brn, sl. sandy silt, mod. stiff,
4			moist, dense, silty-fine sand, gray/brown, no odor
6			
8			
8.2'			semi-dry, dense/mod. stiff, brown, sl. sandy silt
9.0'			moist, dense, silty fine sand, gray/brown
10			
12			

Visual Classification of Subsurface Core

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Port of Seattle	Date	7/12/06
Job No.	050003-02	Core Pushed By	Jaworski (MSS), RB, RP
Exploration No.	—	Core Logged By	R. Booth
Core No.	T30-SI-02	Type of Core	☐ Shelby ☐ Piston Core ☒ Other Vibracore 4"
Water Depth/Elevation of Core	-40.3 ft MLLW	Diameter of Core (inches)	4"
Cored Length (feet; from log)	13 ft	Core Quality	☒ Good ☐ Fair ☐ Poor ☐ Disturbed
Core Recovery (feet)	11.9 ft	Average % Compaction =	

Depth in (ft) — Core Sections (Theoretical / Actual)	Sample Interval	Sample Analytes	Classification and Remarks (Color, Consistency, Moisture, Grain Size, Sheen, Odor)
0.1			Wet, olive, sl. sandy silt, no odor/sheen, several worms present
1 ft			Moist, gray, sandy silt, no odor/no biological
1.8 ft			Moist, sl. silty med. sandy gravel w/2" rock, no odor
2 ft			Moist, clayey silt, gray/black, no odor,
2.8 ft			
3.3 ft			Moist, fine sand, gray, no odor
4			Semi-dry, dense, sl. ~~silty~~ sandy silt, no odor, brown/gray
5			
5.9			Semi-dry, sl. silty fine sand, no odor/sheen, brown/gray
6			Semi-dry, sl. sandy silt, dense, no odor/sheen, brown/gray
8			
8.5 ft			semi-dry, sl. silty sand, dense, no odor/sheen, brown/gray
10			
10.5			Semi-dry, sl. sandy silt, dense, no odor/sheen, brown/gray
11.9 / 12			

Visual Classification of Subsurface Core

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Port of Seattle	Date	7/12/06
Job No.	050003-02	Core Pushed By	Jaworski (MSS), RB, RP
Exploration No.	—	Core Logged By	R. Barth
Core No.	T30-SI-03	Type of Core	☐ Shelby ☐ Piston Core ☒ Other Vibracore
Water Depth/Elevation of Core	-41.3 ft MLLW	Diameter of Core (inches)	4"
Cored Length (feet; from log)	+13 ft	Core Quality	☒ Good ☐ Fair ☐ Poor ☐ Disturbed
Core Recovery (feet)	12.1 ft	Average % Compaction =	

Core Sections: Theoretical / Depth in (ft) / Actual	Sample Interval	Sample Analytes	Classification and Remarks (Color, Consistency, Moisture, Grain Size, Sheen, Odor)
0–0.9			Moist, gray/brown, sl. sandy silt, no odor, few worms on surface, ~0.5cm olive moist silt on surf.
0.9–1.5			Moist, gray/brn, sl. silty sand w/ interspersed gravel, no odor/sheen
1.5–2			same
2–2.2			Moist, brown, sl. silty fibrous wood, mod. S^{2-}
2.2–5.4			Moist, sl. silty fine sand, gray/brown, no odor/sheen
5.4–8			Moist, dense, gray/brown, sl. sandy silt, no odor/sheen
8–10			same
10–12			same, less moist

Visual Classification of Subsurface Core

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Port of Seattle	Date	7/13/06
Job No.	050003-02	Core Pushed By	RP, RB, MSS (Bill Jaworski)
Exploration No.		Core Logged By	SS, RP, LV
Core No.	T30-S3-02	Type of Core	☐ Shelby ☐ Piston Core ☒ Other VIBE
Water Depth/Elevation of Core	-47.1 ft MLLW	Diameter of Core (inches)	4"
Cored Length (feet; from log)	13 ft	Core Quality	☒ Good ☐ Fair ☐ Poor ☐ Disturbed
Core Recovery (feet)	12.4 ft	Average % Compaction =	

Depth in ( ) Theoretical / Actual — Core Sections	Sample Interval	Sample Analytes	Classification and Remarks (Color, Consistency, Moisture, Grain Size, Sheen, Odor)	Sheen	Odor	Biological
0–1'			Moist gry/blk sandy silt			worms, fibrous wood debris
1'			Dense gry/blk slt. sandy silty clay			fibrous wood debris
			Dense, moist gry/blk med. sand			
2'			dense gry/blk sandy silt			
3'			Dense, moist gry/blk sandy silt			
4'						
5'			Dense gry/blk fine sandy clay			
6'						

Visual Classification of Subsurface Core

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Port of Seattle	Date	7/13/06
Job No.	050003-02	Core Pushed By	RP, RB, MSS (BILL JAWORSKI)
Exploration No.		Core Logged By	RP, SS, LV
Core No.	T30-S1-01	Type of Core	☐ Shelby ☐ Piston Core ☒ Other VIBRACORE 4"
Water Depth/Elevation of Core	-46.8 ft MLLW	Diameter of Core (inches)	4
Cored Length (feet; from log)	13 ft	Core Quality	☒ Good ☐ Fair ☐ Poor ☐ Disturbed
Core Recovery (feet)	12.7 ft	Average % Compaction =	

Depth in ( ) Core Sections (Theoretical / Actual)	Sample Interval	Sample Analytes	Classification and Remarks (Color, Consistency, Moisture, Grain Size, Sheen, Odor)	BIOLOGICAL	SHEEN	ODOR
0–.25			Moist, gry/blk sandy silt	wood debris, shells		
.25 – 1.75 (1')			Moist gry/blk Med. sand			
1.75 – 3.75 (2', 3')			Dense silt. fine sand clay; gry			
3.75 – 4.1 (4')			Moist gry/blk Med. sand			
4.1 – 6 (5')			Gry/Blk silt. fine sandy silt			
6'			END OF CORE			
7'						

VOC, S^{2-} TAKEN FROM THIS CORE

Visual Classification of Subsurface Core

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Port of Seattle	Date	7/13/06
Job No.	050003-02	Core Pushed By	RP, RB, MSS (BILL JAWORSKI)
Exploration No.		Core Logged By	RP, SS, LV
Core No.	T30-SS-01-AA/AB	Type of Core	☐ Shelby ☐ Piston Core ☒ Other VIBRACORE 4"
Water Depth/Elevation of Core	~45.5 ft MLLW	Diameter of Core (inches)	4
Cored Length (feet; from log)	13 ft	Core Quality	☒ Good ☐ Fair ☐ Poor ☐ Disturbed
Core Recovery (feet)	12.3 ft	Average % Compaction =	

Depth in ( ) Core Sections (Theoretical / Actual)	Sample Interval	Sample Analytes	Classification and Remarks (Color, Consistency, Moisture, Grain Size, Sheen, Odor)	BIOLOGICAL	SHEEN	ODOR
.2		PSSDA	Gry/Blk, Moist silty sandy clay			
		CST	Moist bry/blk Med. Sand	Fiborous wood debris		
1' / 1.3			Olive/bry silty clay			
2'			Gry/Blk Med. sand, shell hash	Shell hash		
3' / 3.3			Dense silty clay; gry/blk			
4'						
5'						
5.7			Dense gry/blk Med sand			
6'			Dense gry/blk silty clay			
7'			END OF CORE			

Visual Classification of Subsurface Core

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Port of Seattle	Date	7/13/06
Job No.	050003-02	Core Pushed By	RP, RB, MSS (BILL JAWORSKI)
Exploration No.		Core Logged By	RP, SS, LV
Core No.	T30-S5-01-BA/BB	Type of Core	☐ Shelby ☐ Piston Core ☒ Other VIBRACORE 4"
Water Depth/Elevation of Core	-46.0 ft MLLW	Diameter of Core (inches)	4
Cored Length (feet; from log)	13 ft	Core Quality	☒ Good ☐ Fair ☐ Poor ☐ Disturbed
Core Recovery (feet)	12.6 ft	Average % Compaction =	

Depth in ( ) Core Sections – Theoretical	Actual	Sample Interval	Sample Analytes	Classification and Remarks (Color, Consistency, Moisture, Grain Size, Sheen, Odor)	BIOLOGICAL	SHEEN	ODOR
1	1'3"			dry medium sand with small pockets of clay grey to dk. grey shell hash dry			no odor thru out
				clayey silt with fine sand			
2				clayey silt firm ~~dry~~ grey slightly moist			
3				clayey sand (fine sand) moist grey			
4							
				fine sand (3-4" lens) grey dry			
5				clayey send moist			
6				~~fine sand with clay moist~~ clayey silt with some sand grey moist			
				← end of processed core →			
7				medium sand grey dry			
				END OF CORE			

APPENDIX G

Data Management

Appendix G Data Management

AVERAGING LABORATORY REPLICATE SAMPLES

Chemical concentrations obtained from the analysis of laboratory replicate samples (two or more analyses of the same sample) will be averaged for a closer representation of the "true" concentration as compared to the result of a single analysis. Averaging rules are dependent on whether the individual results are detected concentrations or reporting limits (RLs) for undetected chemicals. If all concentrations are detected for a single chemical, the values are simply averaged arithmetically for the sample and its associate laboratory replicate sample(s). If all concentrations are undetected for a given parameter, the minimum RL is selected. If the concentrations are a mixture of detected concentrations and RLs, any two or more detected concentrations are averaged arithmetically and RLs ignored. If there is a single detected concentration and one or more RLs, the detected concentration is reported. The latter two rules are applied regardless of whether the RLs are higher or lower than the detected concentration.

LOCATION AVERAGING

Results of chemical concentrations of discrete samples collected at a single sampling location that are submitted to the laboratory as individual samples and analyzed separately will be averaged for the purposes of mapping a single concentration per location. The averaging rules used for location averaging are the same as for laboratory replicate samples described above. This type of averaging is performed when multiple sediment samples are collected from the same location at the same time. For example: a sample and its field duplicate sample, often referred to as a split sample (PSEP 1997).

SIGNIFICANT FIGURES AND CALCULATIONS

Analytical laboratories report results with various numbers of significant figures depending on the laboratory's standard operating procedures, the instrument, the chemical, and the reported chemical concentration relative to the RL. The reported (or assessed) precision of each result is explicitly stored in the project database by recording the number of significant figures. Tracking of significant figures is used when calculating analyte sums and performing other data summaries. When a calculation involves addition, such as totaling PCBs, the calculation can only be as precise as the least precise number that went into the calculation. For example:

> 210 + 19 = 229 would be reported as 230 because although 19 is reported to two significant digits, the trailing zero in the number 210 is not significant.

When a calculation involves multiplication or division, the final result is rounded at the end of the calculation to reflect the value used in the calculation with the fewest significant figures. For example:

> 59.9 × 1.2 = 71.88 would be reported as 72 because there are two significant figures in the number 1.2.

When rounding, if the number following the last significant figure is less than 5, the digit is left unchanged. If the number following the last significant figure is equal to or greater than 5, the digit is increased by 1.

Many of the Washington State Sediment Management Standards (SMS) chemical criteria are in units normalized to the TOC content in the sediment sample (i.e., milligrams per kilogram organic carbon [mg/kg OC]). Only samples with TOC concentrations greater than or equal to 0.5% or less than or equal to 4.0% are considered appropriate for OC normalization. Samples with TOC concentrations less than 0.5% or greater than 4.0% are compared to dry weight chemical criteria. Chemical concentrations originally in units of micrograms per kilogram (µg/kg) dry weight were converted to mg/kg OC using the following equation:

$$\frac{(C_{\mu g/kg\ dry\ weight}) \times (0.001\ mg/\mu g)}{TOC}$$

Where:

C = the chemical concentration

TOC = the percent total organic carbon on a dry weight basis, expressed as a decimal (e.g., 1% = 0.01)

BEST RESULT SELECTION FOR MULTIPLE RESULTS

In some instances, the laboratory generates more than one result for a chemical for a given sample. Multiple results can occur for several reasons, including: 1) the original result did not meet the laboratory's internal quality control (QC) guidelines, and a reanalysis was performed; 2) the original result did not meet other project data quality objectives, such as a sufficiently low RL, and a reanalysis was performed; or 3) two different analytical methods were used for that chemical. In each case, a single best result is selected for use. The procedures for selecting the best result differ depending on whether a single or multiple analytical methods are used for that chemical.

For the same analytical method, if the results are:

- Detected and not qualified, then the result from the lowest dilution is selected, unless multiple results from the same dilution are available, in which case, the result with the highest concentration is selected.
- A combination of estimated and unqualified detected results, then the unqualified result is selected. This situation most commonly occurs when the original result is outside of calibration range, thus requiring a dilution.

- All estimated, then the "best result" is selected using best professional judgment in consideration of the rationale for qualification. For example, a result qualified based on laboratory replicate results outside of QC objectives for precision would be preferred to a qualified result that is outside the calibration range.
- A combination of detected and undetected results, then the detected result is selected. If there is more than one detected result, the applicable rules for multiple results (as discussed above) are followed.
- All undetected results, then the lowest RL is selected.

If the multiple results are from different analytical methods, then the result from the preferred method specified in the quality assurance project plan (QAPP) or based on the consensus of the professional opinions of project chemists was selected.

The following rules are applied to multiple results from different analytical methods:

- For detected concentrations analyzed by the SVOC full-scan and selective ion monitoring (SIM) methods (i.e., PAHs), the highest detected concentration is selected. If the result by one method is detected and the result by the other method is not detected, then the detected result is selected for reporting, regardless of the method. If results are reported as non-detected by both methods, the undetected result with the lowest RL is selected. The SIM method is more analytically sensitive than the full-scan SVOC method, and the undetected results are generally reported at a lower RL by the SIM method than by the full-scan method. Therefore, the SIM method is selected for non-detected results unless an analytical dilution or analytical interferences elevated the SIM RL above the SVOC full-scan RL.
- Hexachlorobenzene and hexachlorocyclopentadiene are analyzed by EPA Methods 8081A, 8270, and/or 8270-SIM. The result from the method with the greatest sensitivity (i.e., lowest RL) is selected if all results are undetected. EPA Method 8081A results are generally selected, when available, because the standard laboratory RLs from this analysis are significantly lower than those from EPA Methods 8270 and 8270-SIM. When chemicals are detected, the detected result with the highest concentration is selected unless the detected concentration is qualified as estimated or tentatively identified, in which case the rule designating treatment of qualified and unqualified data would apply.

CALCULATED TOTALS

Total PCBs, total dichloro-diphenyl-trichloroethane (DDTs), total PAHs, and total chlordane are calculated by summing the detected values for the individual components available for each sample. For individual samples in which none of the individual components is detected, the total value is given a value equal to the highest

RL of an individual component, and assigned the same qualifier (U or UJ), indicating an undetected result. Concentrations for the analyte sums are calculated as follows:

- **Total PCBs** are calculated, in accordance with the methods of the SMS, using only detected values for seven Aroclor mixtures.[1] For individual samples in which none of the seven Aroclor mixtures is detected, total PCBs are given a value equal to the highest RL of the seven Aroclors and assigned a U-qualifier indicating the lack of detected concentrations.
- **Total low-molecular-weight PAHs (LPAHs), high-molecular-weight PAHs (HPAHs), PAHs, and benzofluoranthenes** are also calculated in accordance with the methods of the SMS. Total LPAHs are the sum of detected concentrations for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. Total HPAHs are the sum of detected concentrations for fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. Total benzofluoranthenes are the sum of the b (i.e., benzo(b)fluoranthene), j, and k isomers. Because the j isomer is rarely quantified, this sum is typically calculated with only the b and k isomers. For samples in which all individual compounds within any of the three groups described above are undetected, the single highest RL for that sample represents the sum.
- **Total DDTs** are calculated using only detected values for the DDT isomers: 2,4′-DDD; 4,4′-DDD; 2,4′-DDE; 4,4′-DDE; 2,4′-DDT; and 4,4′-DDT. For individual samples in which none of the isomers are detected, total DDTs are given a value equal to the highest RL of the six isomers and assigned a U-qualifier, indicating the lack of detected concentrations.
- **Total chlordane** is calculated using only detected values for the following compounds: alpha-chlordane, gamma-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor. For individual samples in which none of these compounds is detected, total chlordane is given a value equal to the highest RL of the five compounds listed above and assigned a U-qualifier, indicating the lack of detected concentrations.

CALCULATION OF DIOXIN/FURAN CONGENER TEQS

Dioxin/furan congener TEQs are calculated using the WHO consensus TEF values (Van den Berg et al. 2006) for mammals as presented in Table E-2. The TEQ is calculated as the sum of each congener concentration multiplied by the corresponding TEF value. When the congener concentration is reported as undetected, then the TEF is multiplied by half the RL.

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[1] Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.

Table 1. Dioxin/furan congener TEF values for mammals

Dioxin/Furan Congener	TEF Value (unitless)
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.01
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.01
1,2,3,4,7,8-Hexachlorodibenzofuran	0.1
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran	0.1
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran	0.1
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.1
1,2,3,7,8-Pentachlorodibenzofuran	0.03
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	1
2,3,4,6,7,8-Hexachlorodibenzofuran	0.1
2,3,4,7,8-Pentachlorodibenzofuran	0.3
2,3,7,8-Tetrachlorodibenzofuran	0.1
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1
Octachlorodibenzofuran	0.0003
Octachlorodibenzo-p-dioxin	0.0003

TEF – toxic equivalency factor

CALCULATION OF CARCINOGENIC POLYCYCLIC AROMATIC HYDROCARBONS

Carcinogenic polycyclic aromatic hydrocarbons (cPAH) values are calculated using TEF values (California EPA 1994; Ecology 2001) based on the individual PAH component's relative toxicity to benzo(a)pyrene. TEF values are presented in Table E-3. The cPAH is calculated as the sum of each individual PAH concentration multiplied by the corresponding TEF value. When the individual PAH component concentration is reported as non-detected, then the TEF is multiplied by half the RL.

Table G-2. cPAH TEF Values

cPAH	TEF Value (unitless)
Benzo(a)pyrene	1
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Bibenz(a,h)anthracene	0.4
Indeno(1,2,3-cd)pyrene	0.1
Chrysene	0.01

cPAH – carcinogenic polycyclic aromatic hydrocarbon
TEF – toxic equivalency factor

REFERENCES

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Ecology. 2001. Model Toxics Control Act Cleanup Regulation, Chapter 173-340 WAC. Publication No. 94-06. Toxics Cleanup Program, Washington State Department of Ecology, Olympia, WA.

PSEP. 1997. Recommended guidelines for sampling marine sediment, water column, and tissue in Puget Sound. Final report. Prepared for the US Environmental Protection Agency, Seattle, WA. Puget Sound Water Quality Action Team, Olympia, WA.

Van den Berg M, Birnbaum LS, Denison M, De Vito M, Farland W, Feeley M, Fiedler H, Hakansson H, Hanberg A, Haws L, Rose M, Safe S, Schrenk D, Tohyama C, Tritscher A, Tuomisto J, Tysklind M, Walker N, Peterson RE. 2006. The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Tox Sci 93(2):223-241.

APPENDIX H

ARI's Quality Control Limits

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Summary of Laboratory Control Limits Metals Analyses
(All Methods & Sample Matrices)

Effective 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Element	Matrix Spike Recovery	LCS Recovery	Replicate RPD
Aluminum	75 - 125	80 - 120	≤ 20%
Antimony	75 - 125	80 - 120	≤ 20%
Arsenic	75 - 125	80 - 120	≤ 20%
Barium	75 - 125	80 - 120	≤ 20%
Beryllium	75 - 125	80 - 120	≤ 20%
Boron	75 - 125	80 - 120	≤ 20%
Cadmium	75 - 125	80 - 120	≤ 20%
Calcium	75 - 125	80 - 120	≤ 20%
Chromium	75 - 125	80 - 120	≤ 20%
Cobalt	75 - 125	80 - 120	≤ 20%
Copper	75 - 125	80 - 120	≤ 20%
Iron	75 - 125	80 - 120	≤ 20%
Lead	75 - 125	80 - 120	≤ 20%
Magnesium	75 - 125	80 - 120	≤ 20%
Manganese	75 - 125	80 - 120	≤ 20%
Mercury	75 - 125	80 - 120	≤ 20%
Nickel	75 - 125	80 - 120	≤ 20%
Potassium	75 - 125	80 - 120	≤ 20%
Selenium	75 - 125	80 - 120	≤ 20%
Silica	75 - 125	80 - 120	≤ 20%
Silver	75 - 125	80 - 120	≤ 20%
Sodium	75 - 125	80 - 120	≤ 20%
Strontium	75 - 125	80 - 120	≤ 20%
Thallium	75 - 125	80 - 120	≤ 20%
Vanadium	75 - 125	80 - 120	≤ 20%
Zinc	75 - 125	80 - 120	≤ 20%

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Summary of Laboratory Control Limits - SIM Analysis for Butyl Tin Species [1, 2] **EPA Method SW-846-8270D (Modified)** Effective 5/1/09			
Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip			
	ARI's Calculated Control Limits		
Sample Matrix	**Pore Water [4]**	**Water [5]**	**Soil/Sediment[6]**
Sample Amount / Final Volume:	**40 mL / 0.5 mL**	**100 mL / 0.5 mL**	**5 g / 0.5 mL**
LCS Spike Recovery [3]			
Tributyl Tin	23 - 133	60 - 125	40 - 144
Dibutyl Tin	30 - 118	30 - 160 [7]	34 - 115
Butyl Tin	**10** - 113	30 - 160 [7]	**10** - 111
Method Blank/LCS Surrogate Recovery			
Tripentyl Tin	38 - 127	48 - 110	35 - 130
Tripropyl Tin	29 - **100**	42 - 113	28 - 106
Sample Surrogate Recovery			
Tripentyl Tin	30 - 135	35 - 124	25 - 140
Tripropyl Tin	28 - **100**	41 - 112	32 - 104

1. Instrument calibrated using hexyl (C_6) derivatives. Results reported as butylated Tin ion.
2. Highlighted control limits (**bold font**) adjusted to demonstrate that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.
3. Laboratory Control Sample (LCS) spike recovery control limits also used as advisory control limits for sample matrix spike (MS) analyzes. MS recovery values are advisory and not used to assess the acceptability of an analytical batch.
4. Control Limits calculated using all data generated 1/1/07 through 5/30/08.
5. Control limits calculated using all data generated 10/1/06 through 5/30/08.
6. Control Limits calculated using all data generated 6/1/06 through 6/1/08 (sample surrogates 6/1/07-6/1/08)
7. Default limits due to insufficient number of data points to calculate historic limits.

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Spike Recovery Control Limits - Analysis of PCB / Aroclors in Soil & Sediment Samples - EPA SW-846 Method 8082

Effective 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

	Routine Analysis	PSDDA	Low Level	Low level	Soxhlet Extraction	Medium Level
Typical Reporting Limit (µg/kg):	**33**	**20**	**10**	**4**	**100**	**800**
Nominal Sample Wet Weight (g):	**12**	**25**	**25**	**25**	**10**	**5**
Final Extract Volume (mL):	**4**	**5**	**2.5**	**1**	**10**	**40**
LCS Spike Recovery (1,2)						
Aroclor 1016	48 - 106	52 - 101	53 - **100**	37 - 106	30 - 160[3]	59 - 108
Aroclor 1260	50 - 121	52 - 126	58 - 112	50 - 116	30 - 160[3]	43 - 177
Method Blank / LCS Surrogate Recovery						
Tetrachloro-*meta*-xylene (TCMX)	46 - 111	47 - 110	43 - 108	35 - 100	30 - 160[3]	49 - 110
Decachlorobiphenyl	51 - 112	48 - 119	48 - 118	40 - 109	30 - 160[3]	51 - 127
Sample Surrogate Recovery						
Tetrachloro-*meta*-xylene (TCMX)	50 - 114	46 - 113	35 - 119	38 - 102	30 - 160[3]	28 - 106
Decachlorobiphenyl	42 - 127	40 - 130	33 - 143	34 - 141	30 - 160[3]	22 - 168

(1) Laboratory Control Sample (LCS) spike recovery control limits also used as advisory control limits for sample matrix spike (MS) analyzes. MS recovery values are advisory and not used to assess the acceptability of an analytical batch.
(2) Highlighted control limits (**bold font**) adjusted to demonstrate that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.
(3) 30 – 160 are default, advisory control limits used when there is insufficient data to calculate historic control limits. **DO NOT** use these limits as the sole reason to reject the data from a batch of analyses.

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Spike Recovery Control Limits Analysis of PCB / Aroclors in Aqueous Samples - EPA SW-846 Methods 8081 & 8082 [1,2]

Effective 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Analytical Method:	Standard Analysis	MTCA Analysis	Low Level Analysis	Manchester Extraction
Sample Weight / Final Volume:	500 / 5 mL	500 / 1 mL	1000 / 0.5 mL	3000 / 1 mL
LCS Spike Recovery [4]				
Aroclor 1016	45 - 121	36 - **100**	44 - 117	30 - 160[3]
Aroclor 1260	54 - 129	41 - 113	46 - 131	30 - 160[3]
Method Blank/LCS Surrogate Recovery				
Tetrachloro-*meta*-xylene (TCMX)	40 - 118	29 - **100**	31 - **100**	30 - 160[3]
Decachlorobiphenyl	41 - 111	35 - 116	32 - 108	30 - 160[3]
Sample Surrogate Recovery				
Tetrachloro-*meta*-xylene (TCMX)	38 - 118	25 - **100**	21 - **100**	30 - 160[3]
Decachlorobiphenyl	29 - 118	**10** - 128	19 - 111	30 - 160[3]

(1) Control Limits calculated using all data generated 1/1/08 through 12/1/08.
(2) Highlighted control limits (**bold font**) adjusted to demonstrate that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.
(3) 30 – 160 are default, advisory control limits used when there is insufficient data to calculate historic control limits. **DO NOT** use these limits as the sole reason to reject the data from a batch of analyses.
(4) Laboratory Control Sample (LCS) spike recovery control limits also used as advisory control limits for sample matrix spike (MS) analyzes. MS recovery values are advisory and not used to assess the acceptability of an analytical batch.

Spike Recovery Control Limits for Chlorinated Pesticides
EPA Method SW-846-8081B Analysis of Aqueous Samples [1,5]

Effective 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Sample Volume / Final Volume	500 mL to 5 mL		1000 / 1 mL	
LCS Spike Recovery [4]	**Control Limits**	**ME Limits [2]**	**Control Limits**	**ME Limits [2]**
α-BHC	56 - 122	45 - 133	32 - 129	16 - 145
β-BHC	52 - 127	40 - 140	30 - 132	13 - 149
δ-BHC	59 - 128	48 - 140	**10** - 163	**10** - 189
γ-BHC (Lindane)	59 - 120	49 - 130	35 - 135	18 - 152
Heptachlor	50 - 133	36 - 147	34 - 115	21 - 129
Aldrin	51 - 113	41 - 123	32 - 115	18 - 129
Hepachlor Epoxide	58 - 125	47 - 136	41 - 138	25 - 154
Endosulfan I	67 - 118	59 - 127	37 - 131	21 - 147
Dieldrin	68 - 122	59 - 131	42 - 134	27 - 149
4,4'-DDE	67 - 131	56 - 142	42 - 147	25 - 165
Endrin	68 - 134	57 - 145	28 - 152	**10** - 173
Endosulfan II	68 - 133	57 - 144	36 - 141	19 - 159
4,4'-DDD	66 - 138	54 - 150	30 - 159	**10** - 181
Endosulfan Sulfate	60 - 132	48 - 144	22 - 140	**10** - 160
4,4'-DDT	68 - 126	58 - 136	20 - 165	**10** - 189
Methoxychlor	62 - 134	50 - 146	16 - 168	**10** - 193
Endrin Ketone	60 - 139	47 - 152	39 - 148	21 - 166
Endrin Aldehyde	27 - 133	**10** - 151	**10** - 120	**10** - 138
γ-Chlordane	59 - 121	49 - 131	42 - 128	28 - 142
α-Chlordane	65 - 118	56 - 127	45 - 129	31 - 143
MB / LCS Surrogate Recovery				
Tetrachloro-*m*-xylene (TCMX)	46 - **100**	(3)	28 - **100**	(3)
Decachlorobiphenyl	39 - 114	(3)	46 - 104	(3)
Sample Surrogate Recovery				
Tetrachloro-xylene (TCMX)	27 - 130	(3)	18 - **100**	(3)
Decachlorobiphenyl	21 - 126	(3)	14 - 120	(3)

(1) Control limits calculated using all recovery data from 1/1/08 through 12/1/08.
(2) **ME** = A **marginal exceedance** defined in the NELAC Standard [6] as beyond the LCS-CL but still within the ME limits. ME limits are between 3 and 4 standard deviations around the mean. A maximum of one marginal exceedance is acceptable. Two or more marginal exceedances require corrective action.
(3) Marginal Exceedances not allowed for a surrogate standard.
(4) Laboratory Control Sample (LCS) spike recovery control limits also used as advisory control limits for sample matrix spike (MS) analyzes. MS recovery values are advisory and not used to assess the acceptability of an analytical batch.
(5) Highlighted control limits (**bold font**) adjusted to demonstrate that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.
(6) **2003 NELAC Standard (EPA/600/R-04/003), July 2003**, Chapter 5, pages 251-252.

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Spike Recovery Control Limits for Chlorinated Pesticides
EPA Method SW-846-8081B Analysis of Soil / Sediment Samples (1,2)

Effective 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Sample Dry Weight / Final Vol.	**12 g to 4 mL**		**25 g to 5 mL**	
LCS Spike Recovery (5)	**Control Limits**	**ME Limits(3)**	**Control Limits**	**ME Limits(3)**
α-BHC	41 - 122	28 - 136	37 - 130	22 - 146
β-BHC	47 - 126	34 - 139	40 - 131	25 - 146
δ-BHC	46 - 138	31 - 153	39 - 142	22 - 159
γ-BHC (Lindane)	49 - 124	37 - 137	43 - 127	29 - 141
Heptachlor	45 - 121	32 - 134	42 - 122	29 - 135
Aldrin	44 - 125	31 - 139	43 - 127	29 - 141
Hepachlor Epoxide	47 - 128	34 - 142	43 - 129	29 - 143
Endosulfan I	42 - 139	26 - 155	31 - 157	10 - 178
Dieldrin	42 - 140	26 - 156	49 - 131	35 - 145
4,4'-DDE	56 - 144	41 - 159	48 - 146	32 - 162
Endrin	50 - 143	35 - 159	52 - 133	39 - 147
Endosulfan II	52 - 133	39 - 147	38 - 137	22 - 154
4,4'-DDD	55 - 140	41 - 154	51 - 139	36 - 154
Endosulfan Sulfate	40 - 133	25 - 149	33 - 133	16 - 150
4,4'-DDT	53 - 133	40 - 146	50 - 131	37 - 145
Methoxychlor	58 - 123	47 - 134	35 - 138	18 - 155
Endrin Ketone	40 - 144	23 - 161	31 - 146	12 - 165
Endrin Aldehyde	12 - 110	**10** - 126	18 - 166	**10** - 191
γ-Chlordane	51 - 125	39 - 137	46 - 127	33 - 141
α-Chlordane	47 - 130	33 - 144	47 - 128	34 - 142
MB / LCS Surrogate Recovery				
Tetrachloro-*m*-xylene (TCMX)	44 - 107	(4)	50 - 124	(4)
Decachlorobiphenyl	51 - 127	(4)	42 - 110	(4)
Sample Surrogate Recovery				
Tetrachloro-xylene (TCMX)	32 - 130	(4)	40 - 119	(4)
Decachlorobiphenyl	51 - 128	(4)	42 - 137	(4)

(1) ARI's Control limits calculated using all available spike recovery data from 1/1/08 or 12/1/08.
(2) Highlighted control limits (**bold font**) adjusted to demonstrate that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.
(3) **ME** = A **marginal exceedance** defined in the NELAC Standard (6) as beyond the LCS-CL but still within the ME limits. ME limits are between 3 and 4 standard deviations around the mean. A maximum of one marginal exceedance is acceptable. Two or more marginal exceedances require corrective action.
(4) Marginal Exceedances not allowed for a surrogate standard.
(5) Laboratory Control Sample (LCS) spike recovery control limits also used as advisory control limits for sample matrix spike (MS) analyzes. MS recovery values are advisory and not used to assess the acceptability of an analytical batch.
(6) **2003 NELAC Standard (EPA/600/R-04/003), July 2003**, Chapter 5, pages 251-252.

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Spike Recovery Control Limits for Analysis of Soil & Sediment Semi-Volatile Organic Compounds (SVOA) EPA SW-846 Method 8270D with Ultrasonic Extraction (1,8)

Effective: 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Extraction / Analytical Method:	**8270D**	**8270D ME(2)**	**PSEP (3)**	**PSEP ME(2,3)**
Sample Weight / Final Volume:	7.5 g to 0.5 mL	7.5 g to 0.5 mL	50 to 1 mL	50 to 1 mL
LCS Spike Recovery (9)				
Phenol	48 - **100**	41 - **100**	31 - 102	19 - 114
Bis-(2-chloroethyl) ether	32 - **100**	22 - 104	30 - **100**	20 - **100**
2-Chlorophenol	44 - **100**	37 - **100**	36 - **100**	28 - **100**
1,3-Dichlorobenzene	39 - **100**	33 - **100**	32 - **100**	24 - **100**
1,4-Dichlorobenzene	40 - **100**	34 - **100**	33 - **100**	26 - **100**
Benzyl Alcohol	**10** - **100**	**10** - **100**	**10** - **100**	**10** - **100**
1,2-Dichlorobenzene	42 - **100**	36 - **100**	34 - **100**	26 - **100**
2-Methylphenol	44 - **100**	37 - **100**	34 - **100**	24 - 102
2,2'-oxybis(1-chloropropane)	21 - **100**	**10** - 107	29 - **100**	19 - **100**
4-Methylphenol	45 - **100**	37 - 100	39 - **100**	30 - 101
N-Nitroso-di-n-propylamine	36 - **100**	27 - 101	32 - **100**	23 - **100**
Hexachloroethane	35 - **100**	28 - **100**	29 - **100**	21 - **100**
Nitrobenzene	27 - 102	15 - 115	28 - **100**	17 - 105
Isophorone	47 - **100**	39 - 105	46 - **100**	38 - 103
2-Nitrophenol	46 - **100**	40 - **100**	37 - **100**	28 - **100**
2,4-Dimethyphenol	41 - **100**	34 - **100**	19 - **100**	**10** - 103
Bis-(2-chloroethoxy) methane	40 - **100**	32 - **100**	38 - **100**	30 - **100**
Benzoic Acid (4)	**10** - 138	**10** - 159	21 - 123	**10** - 140
2,4-Dichlorophenol	48 - **100**	41 - **100**	39 - **100**	30 - 102
1,2,4-Trichlorobenzene	43 - **100**	35 - **100**	36 - **100**	28 - **100**
Naphthalene	44 - **100**	38 - **100**	37 - **100**	29 - **100**
4-Chloroaniline (4)	16 - **100**	**10** - 113	**10** - **100**	**10** - **100**
2-Chloronaphthalene	48 - **100**	42 - **100**	36 - **100**	27 - 101
Hexachlorobutadiene	40 - **100**	33 - **100**	33 - **100**	24 - **100**
4-Chloro-3-methylphenol	50 - **100**	42 - 104	42 - 102	32 - 112
2-Methylnaphthalene	48 - **100**	42 - **100**	41 - **100**	33 - **100**
Hexachlorocyclopentadiene	20 - 114	**10** - 130	15 - 104	**10** - 119
2,4,6-Trichlorophenol	51 - **100**	44 - 100	42 - **100**	33 - 105
2,4,5-Trichlorophenol	50 - **100**	43 - 103	43 - **100**	34 - 107
2-Nitroaniline	45 - **100**	36 - 106	41 - **100**	32 - 108
Dimethylphthalate	53 - **100**	46 - 103	48 - **100**	40 - 106
Acenaphthylene	50 - **100**	43 - 100	42 - **100**	33 - 104
2,6-Dinitrotoluene	54 - 100	46 - 108	44 - 106	34 - 116
3-Nitroaniline (4)	22 - 117	**10** - 133	15 - 108	**10** - 124
Acenaphthene	48 - **100**	41 - **100**	38 - **100**	29 - 102

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Spike Recovery Control Limits for Analysis of Soil & Sediment
Semi-Volatile Organic Compounds (SVOA)
EPA SW-846 Method 8270D with Ultrasonic Extraction (1,8)

Effective: 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Extraction / Analytical Method:	8270D	8270D ME(2)	PSEP (3)	PSEP ME(2,3)
Sample Weight / Final Volume:	7.5 g to 0.5 mL	7.5 g to 0.5 mL	50 to 1 mL	50 to 1 mL
2,4-Dinitrophenol	12 - 147	**10** - 170	20 - 140	**10** - 160
Dibenzofuran	53 - **100**	47 - **100**	45 - **100**	37 - 101
4-Nitrophenol	18 - 107	**10** - 122	21 - 108	**10** - 123
2,4-Dinitrotoluene	57 - 106	49 - 114	48 - 111	38 - 122
Fluorene	54 - **100**	48 - 100	45 - **100**	36 - 106
Diethylphthlalate	52 - 100	44 - 108	48 - 102	39 - 111
4-Chlorophenyl-phenyl ether	54 - **100**	48 - **100**	45 - **100**	36 - 106
4-Nitroaniline	27 - 110	13 - 124	25 - **100**	13 - 110
4,6-Dinitro-2-Methylphenol	21 - 122	**10** - 139	23 - 115	**10** - 130
N-Nitrosodiphenylamine	44 - 145	27 - 162	50 - 128	37 - 141
4-Bromophenyl-phenyl ether	52 - **100**	45 - 101	45 - **100**	36 - 107
Hexachlorobenzene	50 - **100**	42 - 104	44 - 101	35 - 111
Pentachlorophenol	45 - **100**	36 - 108	35 - 105	23 - 117
Phenanthrene	53 - **100**	46 - 101	45 - 100	36 - 109
Anthracene	49 - **100**	41 - 105	43 - **100**	34 - 107
Carbazole	45 - 111	34 - 122	51 - 106	42 - 115
Di-n-butylphthalate	55 - 106	47 - 115	51 - 109	41 - 119
Fluoranthene	54 - 105	46 - 114	52 - 107	43 - 116
Pyrene	48 - 106	38 - 116	41 - 113	29 - 125
Butylbenzylphthalate	46 - 111	35 - 122	40 - 118	27 - 131
Benzo(a)Anthracene	51 - 101	43 - 109	44 - 106	34 - 116
3,3'-Dichlorbenzidine (4)	**10** - 112	**10** - 129	**10** - **100**	**10** - 112
Chrysene	56 - **100**	50 - 102	48 - 102	39 - 111
Bis(2-Ethylhexyl) phthalate	57 - 114	48 - 124	38 - 125	24 - 140
Di-n-octylphthalate	56 - 100	49 - 107	29 - 116	15 - 131
Benzo(b)Fluoranthene	43 - 122	30 - 135	49 - 112	39 - 123
Benzo(k)Fluoranthene	44 - 122	31 - 135	48 - 116	37 - 127
Benzo(a)Pyrene	51 - **100**	43 - 105	41 - **100**	32 - 104
Indeno(1,2,3-cd)Pyrene	38 - 104	27 - 115	29 - 117	14 - 132
Dibenz(a,h)anthracene	41 - 107	30 - 118	34 - 117	20 - 131
Benzo(g,h,i)Perylene	36 - 107	24 - 119	24 - 122	**10** - 138
Aniline (4)	**10** - **100**	**10** - 103	**10** - **100**	**10** - **100**
1,2-Diphenylhydrazine (Azobenzene)	48 - 101	39 - 110	44 - 101	35 - 111
N-Nitrosodimethylamine	31 - **100**	21 - 101	25 - **100**	15 - **100**
1-Methylnaphthalene	48 - **100**	41 - **100**	40 - **100**	31 - 103
Pyridine	**10** - **100**	**10** - **100**	**10** **100**	**10** - **100**

Spike Recovery Control Limits for Analysis of Soil & Sediment Semi-Volatile Organic Compounds (SVOA) EPA SW-846 Method 8270D with Ultrasonic Extraction [1,8]

Effective: 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Extraction / Analytical Method:	8270D	8270D ME[2]	PSEP [3]	PSEP ME[2,3]
Sample Weight / Final Volume:	7.5 g to 0.5 mL	7.5 g to 0.5 mL	50 to 1 mL	50 to 1 mL
MB/LCS Surrogate Recovery				
d4-2-Chlorophenol	43 - **100**	(5)	39 - **100**	(5)
d4-1,2-Dichlorobenzene	34 - **100**	(5)	32 - **100**	(5)
2,4,6-Tribromophenol	47 - 109	(5)	43 - 108	(5)
2-Fluorophenol	14 - 100	(5)	26 - **100**	(5)
d5-Phenol [4]	39 - **100**	**10** - 133	**10** - **100**	**10** - **100**
d5-Nitrobenzene	39 - **100**	(5)	34 - **100**	(5)
2-Fluorobiphenyl	44 - **100**	(5)	39 **100**	(5)
d14-p-Terphenyl	55 - 106	(5)	49 - 112	(5)
Sample Surrogate Recovery				
d4-2-Chlorophenol	33 - **100**	(5)	30 - **100**	(5)
d4-1,2-Dichlorobenzene	30 - **100**	(5)	24 - **100**	(5)
2,4,6-Tribromophenol	28 - 116	(5)	33 - 118	(5)
2-Fluorophenol	**10** - **100**	(5)	21 - **100**	(5)
d5-Phenol [4]	31 - **100**	21 - 101	**10** - **100**	**10** - **100**
d5-Nitrobenzene	32 - **100**	(5)	26 - **100**	(5)
2-Fluorobiphenyl	36 - **100**	(5)	32 - **100**	(5)
d14-p-Terphenyl	35 - 113	(5)	25 - 116	(5)

(1) Control Limits calculated using all data generated 1/1/08 through 12/1/08.
(2) **ME** = A **marginal exceedance** defined in the NELAC Standard [6] as beyond the CL but still within the ME limits. ARI defines ME limits as 4 standard deviations around the mean with upper limit ≥ 100% A maximum of 4 marginal exceedances are acceptable. (≥ 5 marginal exceedances in an analysis require corrective action).
(3). Preparation includes Gel Permeation Chromatography (GPC) clean-up.
(4) These are "**poor performers**" defined in the DoD QSM [7] as compounds that "produce low mean recoveries and high standard deviations, resulting in wide LCS control limits with particularly low lower control limits (sometimes-negative values). ARI does not control batch acceptance based on these compounds since there is a high level of uncertainty in their recovery."
(5) Marginal Exceedances not allowed for surrogate unless it is a "poor performer".
(6) **2003 NELAC Standard (EPA/600/R-04/003), July 2003**, Chapter 5, pages 251-252.
(7) Page 182 of: **Department of Defense Quality Systems Manual for Environmental Laboratories, Version 3 Final, March 2005** Prepared By Environmental Data Quality Workgroup, Department of Navy, Lead Service (Based NELAC Chapter 5 (Quality Systems) NELAC Voted Version − 5 June 2003
(8) Highlighted control limits (**bold font**) adjusted to demonstrate that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.
(9) Laboratory Control Sample (LCS) spike recovery control limits also used as advisory control limits for sample matrix spike (MS) analyzes. MS recovery values are advisory and not used to assess the acceptability of an analytical batch.

Spike Recovery Control Limits for Analysis of Soil & Sediment
Semi-Volatile Organic Compounds (SVOA)
EPA SW-846 Method 8270D with Microwave Extraction[1,8]

(Effective: 6/1/09)

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Extraction / Analytical Method:	**8270D**	**8270D ME[2]**
Sample Weight / Final Volume:	7.5 g to 0.5 mL	7.5 g to 0.5 mL
LCS Spike Recovery [9]		
Phenol	37 - 116	24 - 129
Bis-(2-chloroethyl) ether	43 - 108	32 - 119
2-Chlorophenol	45 - 109	34 - 120
1,3-Dichlorobenzene	47 - 105	37 - 115
1,4-Dichlorobenzene	46 - 105	36 - 115
Benzyl Alcohol	16 - 108	**10** - 123
1,2-Dichlorobenzene	48 - 104	39 - 113
2-Methylphenol	45 - 112	34 - 123
2,2'-oxybis(1-chloropropane)	36 - 114	23 - 127
4-Methylphenol	47 - 114	36 - 125
N-Nitroso-di-n-propylamine	44 - 113	33 - 125
Hexachloroethane	43 - 104	33 - 114
Nitrobenzene	39 - 112	27 - 124
Isophorone	57 - 114	48 - 124
2-Nitrophenol	50 - 112	40 - 122
2,4-Dimethyphenol	40 - 110	28 - 122
Bis-(2-chloroethoxy) methane	49 - 111	39 - 121
Benzoic Acid [4]	**10** - 160	**10** - 185
2,4-Dichlorophenol	51 - 113	41 - 123
1,2,4-Trichlorobenzene	50 - 106	41 - 115
Naphthalene	50 - 108	40 - 118
4-Chloroaniline [4]	17 - 149	**10** - 171
2-Chloronaphthalene	48 - 116	37 - 127
Hexachlorobutadiene	46 - 112	35 - 123
4-Chloro-3-methylphenol	54 - 116	44 - 126
2-Methylnaphthalene	54 - 106	45 - 115
Hexachlorocyclopentadiene	23 - 149	**10** - 170
2,4,6-Trichlorophenol	51 - 114	41 - 125
2,4,5-Trichlorophenol	52 - 116	41 - 127
2-Nitroaniline	51 - 115	40 - 126
Dimethylphthalate	56 - 113	47 - 123
Acenaphthylene	56 - 115	46 - 125
2,6-Dinitrotoluene	54 - 124	42 - 136
3-Nitroaniline [4]	39 - 142	22 - 159
Acenaphthene	48 - 115	37 - 126

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Spike Recovery Control Limits for Analysis of Soil & Sediment
Semi-Volatile Organic Compounds (SVOA)
EPA SW-846 Method 8270D with Microwave Extraction[1,8]

(Effective: 6/1/09)

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Extraction / Analytical Method:	**8270D**	**8270D ME[2]**
Sample Weight / Final Volume:	7.5 g to 0.5 mL	7.5 g to 0.5 mL
2,4-Dinitrophenol	15 - 169	**10** - 195
Dibenzofuran	55 - 111	46 - 120
4-Nitrophenol	23 - 130	**10** - 148
2,4-Dinitrotoluene	57 - 127	45 - 139
Fluorene	55 - 117	45 - 127
Diethylphthlalate	54 - 116	44 - 126
4-Chlorophenyl-phenyl ether	52 - 117	41 - 128
4-Nitroaniline	47 - 124	34 - 137
4,6-Dinitro-2-Methylphenol	**10** - 157	**10** - 182
N-Nitrosodiphenylamine	54 - 138	40 - 152
4-Bromophenyl-phenyl ether	50 - 117	39 - 128
Hexachlorobenzene	50 - 121	38 - 133
Pentachlorophenol	40 - 123	26 - 137
Phenanthrene	55 - 116	45 - 126
Anthracene	57 - 115	47 - 125
Carbazole	60 - 121	50 - 131
Di-n-butylphthalate	60 - 119	50 - 129
Fluoranthene	52 - 129	39 - 142
Pyrene	49 - 134	35 - 148
Butylbenzylphthalate	44 - 144	27 - 161
Benzo(a)Anthracene	56 - 124	45 - 135
3,3'-Dichlorbenzidine [4]	37 - 140	20 - 157
Chrysene	53 - 124	41 - 136
Bis(2-Ethylhexyl) phthalate	63 - 128	52 - 139
Di-n-octylphthalate	59 - 114	50 - 123
Benzo(b)Fluoranthene	58 - 124	47 - 135
Benzo(k)Fluoranthene	53 - 130	40 - 143
Benzo(a)Pyrene	53 - 109	44 - 118
Indeno(1,2,3-cd)Pyrene	40 - 128	25 - 143
Dibenz(a,h)anthracene	47 - 123	34 - 136
Benzo(g,h,i)Perylene	44 - 125	31 - 139
Aniline [4]	**10** - 129	**10** - 149
1,2-Diphenylhydrazine (Azobenzene)	56 - 118	46 - 128
N-Nitrosodimethylamine	43 - 119	30 - 132
1-Methylnaphthalene	55 - 116	45 - 126
Pyridine	15 - 118	**10** - 135

Spike Recovery Control Limits for Analysis of Soil & Sediment Semi-Volatile Organic Compounds (SVOA) EPA SW-846 Method 8270D with Microwave Extraction[1,8]

(Effective: 6/1/09)

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Extraction / Analytical Method:	8270D	8270D ME[2]
Sample Weight / Final Volume:	7.5 g to 0.5 mL	7.5 g to 0.5 mL
MB/LCS Surrogate Recovery		
d4-2-Chlorophenol	50 - 103	(5)
d4-1,2-Dichlorobenzene	48 - 104	(5)
2,4,6-Tribromophenol	54 - 120	(5)
2-Fluorophenol	38 - 112	(5)
d5-Phenol [4]	44 - 110	33 - 121
d5-Nitrobenzene	46 - 102	(5)
2-Fluorobiphenyl	51 - 105	(5)
d14-p-Terphenyl	55 - 124	(5)
Sample Surrogate Recovery		
d4-2-Chlorophenol	36 - 104	(5)
d4-1,2-Dichlorobenzene	38 - 102	(5)
2,4,6-Tribromophenol	31 - 131	(5)
2-Fluorophenol	22 - 108	(5)
d5-Phenol [4]	27 - 112	13 - 126
d5-Nitrobenzene	32 - 106	(5)
2-Fluorobiphenyl	39 - 107	(5)
d14-p-Terphenyl	31 - 130	(5)

(1) Control Limits calculated using all data generated 7/1/08 through 6/30/09.
(2) **ME** = A **marginal exceedance** defined in the NELAC Standard [6] as beyond the CL but still within the ME limits. ARI defines ME limits as 4 standard deviations around the mean with upper limit ≥ 100%. A maximum of 4 marginal exceedances are acceptable. (≥ 5 marginal exceedances in an analysis require corrective action).
(3). Preparation includes Gel Permeation Chromatography (GPC) clean-up.
(4) These are "**poor performers**" defined in the DoD QSM [7] as compounds that "produce low mean recoveries and high standard deviations, resulting in wide LCS control limits with particularly low lower control limits (sometimes-negative values)". ARI does not control batch acceptance based on these compounds since there is a high level of uncertainty in their recovery."
(5) Marginal Exceedances not allowed for surrogate unless it is a "poor performer".
(6) **2003 NELAC Standard (EPA/600/R-04/003), July 2003**, Chapter 5, pages 251-252.
(7) Page 182 of: **Department of Defense Quality Systems Manual for Environmental Laboratories, Version 3 Final, March 2005** Prepared By Environmental Data Quality Workgroup, Department of Navy, Lead Service (Based NELAC Chapter 5 (Quality Systems) NELAC Voted Version − 5 June 2003
(8) Highlighted control limits (**bold font**) adjusted to demonstrate that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.
(9) Laboratory Control Sample (LCS) spike recovery control limits also used as advisory control limits for sample matrix spike (MS) analyzes. MS recovery values are advisory and not used to assess the acceptability of an analytical batch.

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Spike Recovery Control Limits for Analysis of Aqueous Samples
Semi-Volatile Organic Compounds (SVOA) EPA SW-846 Methods 8270D [9]

Effective: 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Extraction Method:	**Liquid-Liquid Extract** [1]	**Liquid-Liquid ME**[1,2]	**Separatory Funnel** [1]	**Separatory Funnel - ME**[1,2]
Sample Weight / Final Volume:	500 to 0.5 mL	500 to 0.5 mL	500 to 0.5 mL	500 to 0.5 mL
LCS Spike Recovery [8]				
Phenol [3]	50 - **100**	43 - 103	16 - **100**	6 - **100**
Bis-(2-chloroethyl) ether	52 - **100**	45 - 105	41 - 112	29 - 124
2-Chlorophenol	56 - **100**	49 - 103	43 - 111	32 - 122
1,3-Dichlorobenzene	23 - **100**	15 - **100**	32 - **100**	22 - 103
1,4-Dichlorobenzene	25 - **100**	17 - **100**	32 - **100**	22 - 103
Benzyl Alcohol	19 - 100	**10** - 114	22 - 100	9 - 113
1,2-Dichlorobenzene	30 - **100**	22 - **100**	34 - **100**	24 - 104
2-Methylphenol	52 - **100**	44 - 106	36 - 110	24 - 122
2,2'-oxybis(1-chloropropane)	32 - 111	19 - 124	29 - 118	14 - 133
4-Methylphenol	53 - 102	45 - 110	38 - 104	27 - 115
N-Nitroso-di-n-propylamine	43 - 104	33 - 114	38 - 115	25 - 128
Hexachloroethane	12 - **100**	**10** - **100**	24 - **100**	13 - 100
Nitrobenzene	33 - 125	18 - 140	45 - 106	35 - 116
Isophorone	57 - 115	47 - 125	55 - 119	44 - 130
2-Nitrophenol	56 - 102	48 - 110	46 - 118	34 - 130
2,4-Dimethyphenol	29 - **100**	20 - **100**	28 - 105	15 - 118
Bis-(2-chloroethoxy) methane	54 - 101	46 - 109	44 - 118	32 - 130
Benzoic Acid [3]	**10** - 131	**10** - 151	11 - **100**	**10** - **100**
2,4-Dichlorophenol	56 - 104	48 - 112	43 - 121	30 - 134
1,2,4-Trichlorobenzene	27 - **100**	18 - **100**	35 - **100**	25 - 107
Naphthalene	45 - **100**	38 - **100**	36 - 111	24 - 124
4-Chloroaniline [3]	**10** - 139	**10** - 161	10 - 174	**10** - 201
2-Chloronaphthalene	45 - **100**	37 - 105	39 - 118	26 - 131
Hexachlorobutadiene	**10** - **100**	**10** - **100**	24 - **100**	12 - 108
4-Chloro-3-methylphenol	53 - 109	44 - 118	45 - 122	32 - 135
2-Methylnaphthalene	46 - **100**	38 - 100	45 - 103	35 - 113
Hexachlorocyclopentadiene	**10** - **100**	**10** - **100**	23 - 108	**10** - 122
2,4,6-Trichlorophenol	58 - 108	50 - 116	48 - 122	36 - 134
2,4,5-Trichlorophenol	58 - 107	50 - 115	48 - 122	36 - 134
2-Nitroaniline	50 - 107	41 - 117	48 - 118	36 - 130
Dimethylphthalate	58 - 107	50 - 115	50 - 120	38 - 132
Acenaphthylene	57 - 100	50 - 107	50 - 119	39 - 131
2,6-Dinitrotoluene	58 - 112	49 - 121	48 - 133	34 - 147
3-Nitroaniline [3]	21 - 150	**10** - 172	54 - 140	40 - 154
Acenaphthene	51 - **100**	43 - 106	41 - 120	28 - 133
2,4-Dinitrophenol	12 - 169	**10** - 195	23 - 176	**10** - 202

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Spike Recovery Control Limits for Analysis of Aqueous Samples
Semi-Volatile Organic Compounds (SVOA) EPA SW-846 Methods 8270D [9]

Effective: 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Extraction Method:	Liquid-Liquid Extract [1]	Liquid-Liquid ME[1,2]	Separatory Funnel [1]	Separatory Funnel - ME[1,2]
Sample Weight / Final Volume:	500 to 0.5 mL	500 to 0.5 mL	500 to 0.5 mL	500 to 0.5 mL
Dibenzofuran	57 - 100	50 - 107	51 - 114	41 - 125
4-Nitrophenol [3]	35 - 119	21 - 133	13 - **100**	**10** - **100**
2,4-Dinitrotoluene	58 - 117	48 - 127	51 - 134	37 - 148
Fluorene	56 - 104	48 - 112	50 - 120	38 - 132
Diethylphthlalate	52 - 111	42 - 121	48 - 122	36 - 134
4-Chlorophenyl-phenyl ether	55 - 104	47 - 112	50 - 118	39 - 129
4-Nitroaniline	49 - 112	39 - 123	42 - 136	26 - 152
4,6-Dinitro-2-Methylphenol	13 - 139	**10** - 160	32 - 121	17 - 136
N-Nitrosodiphenylamine	60 - 136	47 - 149	58 - 141	44 - 155
4-Bromophenyl-phenyl ether	55 - 103	47 - 111	50 - 122	38 - 134
Hexachlorobenzene	54 - 106	45 - 115	47 - 125	34 - 138
Pentachlorophenol	46 - 114	35 - 125	35 - 130	19 - 146
Phenanthrene	56 - 102	48 - 110	49 - 120	37 - 132
Anthracene	56 - 101	49 - 109	53 - 116	43 - 127
Carbazole	60 - 108	52 - 116	57 - 122	46 - 133
Di-n-butylphthalate	56 - 112	47 - 121	57 - 121	46 - 132
Fluoranthene	57 - 110	48 - 119	56 - 119	46 - 130
Pyrene	48 - 119	36 - 131	37 - 143	19 - 161
Butylbenzylphthalate	51 - 114	41 - 125	34 - 152	14 - 172
Benzo(a)Anthracene	55 - 105	47 - 113	49 - 129	36 - 142
3,3'-Dichlorbenzidine [3]	**10** - 128	**10** - 148	50 - 128	37 - 141
Chrysene	55 - 104	47 - 112	45 - 128	31 - 142
bis(2-Ethylhexyl) phthalate	28 - 164	**10** - 187	57 - 133	44 - 146
Di-n-octylphthalate	57 - 107	49 - 115	52 - 120	41 - 131
Benzo(b)Fluoranthene	53 - 112	43 - 122	50 - 126	37 - 139
Benzo(k)Fluoranthene	50 - 116	39 - 127	49 - 126	36 - 139
Benzo(a)Pyrene	45 - 103	35 - 113	46 - 109	36 - 120
Indeno(1,2,3-cd)Pyrene	35 - 118	21 - 132	34 - 136	17 - 153
Dibenz(a,h)anthracene	42 - 119	29 - 132	41 - 134	26 - 150
Benzo(g,h,i)Perylene	39 - 123	25 - 137	41 - 133	26 - 148
Aniline [3]	**10** - **100**	**10** - **100**	28 - 126	12 - 142
1,2-Diphenylhydrazine /Azobenzene	57 - 109	48 - 118	55 - 119	44 - 130
N-Nitrosodimethylamine	49 - **100**	41 - 104	31 - **100**	21 - 105
1-Methylnaphthalene	46 - **100**	37 - 107	43 - 115	31 - 127
1,4-Dioxane	40 - **100**	30 - 108	30 - 160 [4]	30 - 160 [4]
Pyridine	-	-	25 - **100**	15 - **100**
Tributyl Phosphate	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]

Spike Recovery Control Limits for Analysis of Aqueous Samples
Semi-Volatile Organic Compounds (SVOA) EPA SW-846 Methods 8270D [9]

Effective: 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Extraction Method:	Liquid-Liquid Extract [1]	Liquid-Liquid ME[1,2]	Separatory Funnel [1]	Separatory Funnel - ME[1,2]
Sample Weight / Final Volume:	500 to 0.5 mL	500 to 0.5 mL	500 to 0.5 mL	500 to 0.5 mL
Dibutyl Phenyl Phosphate	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]
Butyl Diphenyl Phosphate	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]
Triphenyl Phosphate	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]
Butylated Hydroxytoluene (BHT)	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]	30 - 160 [4]
MB / LCS Surrogate Recovery				
d4-2-Chlorophenol	53 - 100	(5)	49 - 101	(5)
d4-1,2-Dichlorobenzene	38 - **100**	(5)	40 - **100**	(5)
2,4,6-Tribromophenol	52 - 123	(5)	51 - 122	(5)
2-Fluorophenol	46 - **100**	(5)	31 - **100**	(5)
d5-Phenol [3]	50 - 100	52 - 108	19 - **100**	12 - **100**
d5-Nitrobenzene	46 - 100	(5)	46 - 101	(5)
2-Fluorobiphenyl	49 - **100**	(5)	49 - 103	(5)
d14-p-Terphenyl	53 - 119	(5)	49 - 130	(5)
d8-1,4-Dioxane	45 - **100**	(5)	30 - 160 [4]	(5)
Sample Surrogate Recovery				
d4-2-Chlorophenol	44 - **100**	(5)	23 - 104	(5)
d4-1,2-Dichlorobenzene	32 - **100**	(5)	22 - **100**	(5)
2,4,6-Tribromophenol	48 - 118	(5)	22 - 125	(5)
2-Fluorophenol	38 - **100**	(5)	18 - **100**	(5)
d5-Phenol	41 - **100**	32 - 104	**10** - **100**	17 - **100**
d5-Nitrobenzene	39 - **100**	(5)	21 - 106	(5)
2-Fluorobiphenyl	42 - **100**	(5)	26 - 104	(5)
d14-p-Terphenyl	26 - 114	(5)	11 - 132	(5)
d8-1,4-Dioxane	32 - **100**	(5)	30 - 160 [4]	(5)

(1) Control Limits calculated using all data generated 1/1/07 through 12/1/07.
(2) **ME** = A **marginal exceedance** defined in the NELAC Standard [6] as beyond the CL but still within the ME limits. ARI defines ME limits as between 3 and 4 standard deviations around the mean with upper limit ≥ 100%. A maximum of four marginal exceedances are acceptable. Five or more marginal exceedances in an analysis require corrective action.
(3) These are "**poor performers**" defined in the DoD QSM[7] as compounds that "produce low mean recoveries and high standard deviations, resulting in wide LCS control limits with particularly low lower control limits (sometimes-negative values). ARI does not control batch acceptance based on these compounds since there is a high level of uncertainty in their recovery."
(4) 30 – 160 are default, advisory control limits used when there is insufficient data to calculate historic control limits. **DO NOT** use these limits as the sole reason to reject the data from a batch of analyses.
(5) Marginal Exceedances not allowed for surrogate unless it is a "poor performer".
(6) **2003 NELAC Standard (EPA/600/R-04/003), July 2003**, Chapter 5, pages 251-252.
(7) Page 182 of: **Department of Defense Quality Systems Manual for Environmental Laboratories, Version 3 Final, March 2005** Prepared By Environmental Data Quality Workgroup, Department of Navy, Lead Service (Based On National Environmental Laboratory Accreditation Conference (NELAC) Chapter 5 (Quality Systems) NELAC Voted Version − 5 June 2003
(8) Laboratory Control Sample (LCS) spike recovery control limits also used as advisory control limits for sample matrix spike (MS) analyzes. MS recovery values are advisory and not used to assess the acceptability of an analytical batch.
(9) Highlighted control limits (**bold font**) adjusted to demonstrate that ARI does not use control limits < 10 for the lower limit or < 100 for the upper limit.

Analytical Resources,Incorporated
Analytical Chemists and Consultants

Spike Recovery Control Limits for Conventional Wet Chemistry

Effective 5/1/09

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use. http://www.arilabs.com/portal/downloads/ARI-CLs.zip

	ARI's Control Limits	
Sample Matrix:	Water	Soil / Sediment
Matrix Spike Recoveries	% Recovery	% Recovery
Ammonia	75 - 125	75 - 125
Bromide	75 125	75 - 125
Chloride	75 125	75 - 125
Cyanide	75 - 125	75 - 125
Ferrous Iron	75 - 125	75 - 125
Fluoride	75 - 125	75 - 125
Formaldehyde	75 - 125	75 - 125
Hexane Extractable Material	-- - --	78 - 114
Hexavalent Chromium	75 - 125	75 - 125
Nitrate/Nitrite	75 - 125	75 - 125
Oil and Grease	75 - 125	75 - 125
Phenol	75 - 125	75 - 125
Phosphorous	75 - 125	75 - 125
Sulfate	75 - 125	75 - 125
Sulfide	75 - 125	75 - 125
Total Kjeldahl Nitrogen	75 - 125	75 - 125
Total Organic Carbon	75 - 125	75 - 125
Duplicate RPDs		
Acidity	±20%	±20%
Alkalinity	±20%	±20%
BOD	±20%	±20%
Cation Exchange	±20%	±20%
COD	±20%	±20%
Conductivity	±20%	±20%
Salinity	±20%	±20%
Solids	±20%	±20%
Turbidity	±20%	±20%

Summary of Laboratory Control Limits

Default limits of 30-160% recovery and 30% RPD apply for all organic analytes when laboratory generated control limits are not available on ARI's web site. Default limits for all inorganic analytes are 75-125% recovery and 25% RPD.

ARI's laboratory generated Quality Control Limits may be superseded by project specific data quality objectives (DQO) provided by ARI's clients. The use of project specific DQO must be approved by ARI's Laboratory and QA Program Managers.